INSTRUCTION MANUAL

OSCILLOSCOPE

SS-3510

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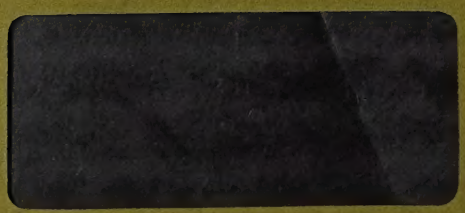

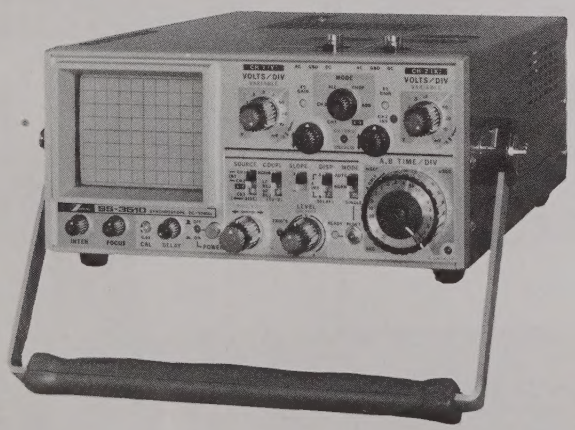

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G2876-616101(I)

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SECTION 1
SPECIFICATION

General

The SS-3510 is a small-sized and light-weight oscilloscope of portable type which covers a wide frequency bandwidth from DC to 50 MHz.

The electronically switched dual-trace vertical deflection system allows the measurement of sum of two signals (ADD) or difference of two signals as well as ordinary dual-trace measurements (ALT and CHOP). Both of two channels are designed for high sensitivity. The vertical deflection factor can be increased up to 2 mV/div with a x5 gain switch.

The horizontal deflection system can be triggered with signals from DC to 50 MHz. The sweep mode which is suited for measuring object can be selected out of the AUTO and NORM. Functions such as sweep of 10 magnifications, delaying sweep, single sweep, X-Y scope operation are provided.

The cathode-ray tube is a square type incorporated with parallax free internal graticule. Effective viewing area is 8 div (vertical) by 10 div (horizontal) in size, and high intensity observation is possible by high accerelating voltage of 12 kV.

Internal circuit is designed for full solid-state structure. Further, outstanding stability and reliability of operation is ensured by drastic use of integrated circuits.

Cathode-Ray Tube (CRT)

CRT Type	Rectangular
Graticule	8 div x 10 div (1 div = 6.35mm). Internal graticule,
Phosphor	B31 (standard)
Accerelating Potential	Approximately 12 kV.

Vertical Deflection System

Display Mode	Channel 1, Channel 2, Alternate display of Channel 1 and Channel 2, Chopped display of Channel 1 and Channel 2 (chopped repetition rate: 250 kHz ±30%), Added display of Channel 1 and Channel 2.

Channel 1 and Channel 2

Deflection Factor	10 mV/div to 5 V/div (x1) 2 mV/div to 1 V/div (x5) in 9 calibrated steps in a 1-2-5 sequence. 2 mV/div to 12.5 V/div continuously variable with variable control and gain change switch. Accuracy: x1: ±3% (10°C to 35°C) ±5% (−10°C to 50°C) x5: ±4% (10°C to 35°C) ±6% (−10°C to 50°C)
Frequency Response	(x1, 10°C to 35°C) 10 mV/div to 50 mV/div: DC to 50 MHz, −3 dB 0.1 V/div to 0.5 V/div: DC to 50 MHz −3.5dB 1 V/div to 5 V/div: DC to 50 MHz −4.5 dB (x5, 10°C to 35°C) DC to 20 MHz −3 dB The AC-coupled lower −3 dB frequency is 4 Hz (0.4 Hz or less with x10 probe).
Rise Time	Approximately 7 ns (x1)
Pulse Response	Overshoot: 6% Sag (1 kHz): 2% Other distortion: 5%

(10 mV/div, x1, 10° C to 35° C)

Delay Line — Allows viewing of leading edge

Input Coupling — AC,GND,DC

Input RC — 1 MΩ ±3%//36pF ±2pF
10 MΩ ±3%//15pF±2pF

Maximum Input Voltage
250V (DC + Peak AC)

Drift — 0.5 div/hour (typical) after a 15-minute warm-up

Common Mode Rejection Ratio
30: 1 or greater at 1 kHz.
20: 1 or greater at 10 MHz.

Polarity Inversion Provided for Channel 2.

Triggering

Source — Internal (Channel 1, Channel 2), External.

Coupling — AC, LF REJ, HF REJ(TV-V), DC(external).

Slope — Positive-going, Negative-going.

External Input RC 1 MΩ±3%//25pF ±5 pF.

External Maximum Input Voltage
250 V (DC + Peak AC).

Sensitivity — Shown in Table 1-1.

Table 1-1 (10°C to 35°C)

Frequency range	Level	
	Internal (display amplitude)	External (input voltage)
DC to 10 MHz	0.5 div	0.3V
10 MHz to 35 MHz	1.0 div	0.4V
35 MHz to 50 MHz	1.5 div	0.5V

Notes:

1. Signals below 10 Hz are attenuated in the AC coupling.
2. Signals below 10 kHz are attenuated in the LF REJ coupling.
3. Signals above 10 kHz are attenuated in the HF REJ coupling.
4. The lower end of triggerable frequency in the automatic sweep mode is 50 Hz.
5. Trigger level in the TV-V coupling is 1 division or more with display amplitude of sync signal portion of composite signal.

Horizontal Deflection System

Display Mode — A sweep, A inensified by B, B sweep.

A Sweep

Sweep Mode — Automatic, Normal, Single

Sweep Rate — 0.1 μs/div to 0.2 s/div in 20 calibrated steps in a 1-2-5 sequence.
0.1 μs/div to 0.5 s/div continuously variable with variable control.
Accuracy 1 [over center 8 divisions] :
±3% (10°C to 35°C)
±5% (−10°C to 50°C)
Accuracy II [over any 2 divisions within 8 divisions] :
±5% (−10°C to 50°C)

Holdoff Time — Continuously variable with control.

B Sweep

Sweep Mode — Automatic, Triggered.

Sweep Rate — 0.1 μs/div to 0.5 ms/div in 12 calibrated steps in a 1-2-5 sequence.
Accuracy I [over center 8 divisions] :
±3% (10°C to 35°C)
±5% (−10°C to 50°C)
Accuracy II [over any 2 divisions within 8 divisions] :
±5% (−10°C to 50°C)

Delay Time — 1 μs to 2 s.

Delay Jitter — 1/20,000 or less.

Sweep Magnification — 10 times.
(Maximum sweep rate: 10 ns/div.)
Magnified sweep rate accuracy I [over center 8 divisions] :
±4% (10°C to 35°C)
Magnified sweep rate accuracy II [over any 2 divisions within center 8 divisions] :
10 ns/div to 50 ns/div ±15%
0.1 μs/div to 20 ms/div ±5%
(10°C to 35°C)

X-Y Operation

Input	X-axis: Channel 2 Y-axis: Channel 1
X-Axis	
Deflection Factor	Same as Channel 2. Accuracy: x1: ±5% (10°C to 35°C) x5: ±6% (10°C to 35°C)
Frequency Response	DC to 1 MHz –3 dB
Input RC	Same as Channel 2.
Maximum Input Voltage	Same as Channel 2.
Y-Axis	Same as Channel 1.
X-Y Phase Difference	3° or less (DC to 50 kHz).

Z Axis

Sensitivity	5 Vp-p for noticeable intensity modulation. Positive-going signal decrease intensity.
Frequency Range	DC to 1 MHz.
Input Resistance	20 kΩ ±10%
Maximum Input Voltage	50 V (DC + Peak AC).

Calibrator

Waveshape	Square wave.
Repetition Rate	1 kHz ±30%
Durty Ratio	40% to 60%
Output Voltage	0.6V. Accuracy: ±1% (10°C to 35°C)

Power Supply

Line Voltage	100 V AC (85 to 130 V)/200 V AC(170 to 260 V) internal switch selection.
Line Frequency	50 to 400 Hz.
Power Consumption	Approximately 25 W (at 100 VAC).

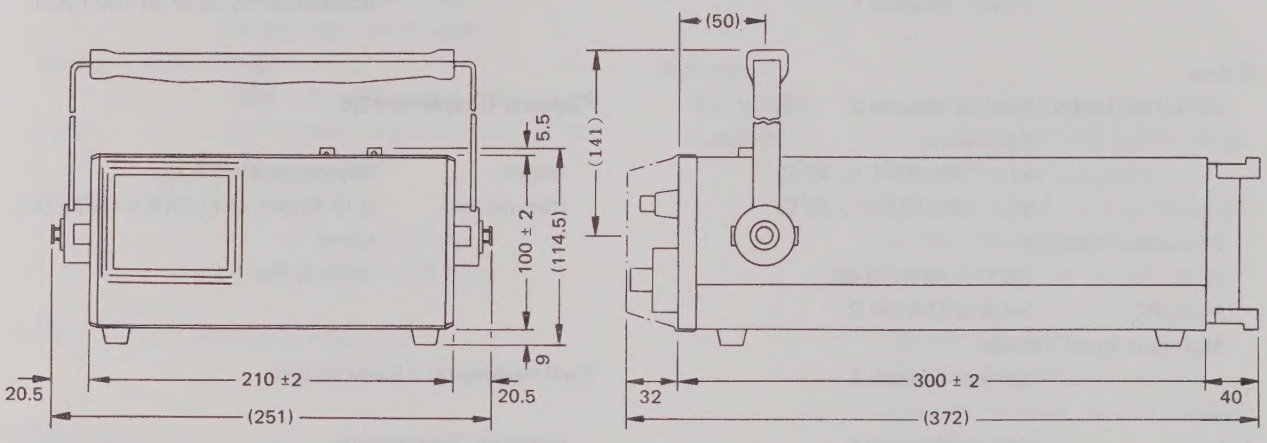
Physical Characteristic

Weight	Approximately 3.9 kg.
Dimensions	(210 ±2)W x (100 ±2)H x (300 ±2) L mm. Refer to Fig. 1-1.

Environmental Characteristic

Operating Temperature	–10°C to 50°C.
Operating Humidity	90% RH, 40°C.
Storage Temperature	–20°C to 70°C.
Storage Humidity	80% RH, 70°C.
Altitude	Operating: 5,000 m maximum (balometric pressure: 405 mmHg) Non-operating: 15,000m maximum (balometric pressure: 90.4 mmHg)
Vibration (non-operating)	Vibrate for 15 minutes along each axis at a total displacement of 0.67 mm p-p with the frequency varied from 10-55 Hz in one-minute cycle.
Shock (non-operating)	Lift one bottom edge of the instrument 5 cm over a hard bench, and drop. (30° maximum in elevation angle) Repeate 3 times for each edge.
Drop (package drop)	Drop from a height of 90 cm on one corner, all edges radiating from that corner and all flat surfaces.

Fig. 1-1 Dimensions



SECTION 2
OPERATING INFORMATION

Handle, Rubber feet and Power-cord Winder

The handle of this instrument can turn and stop at an interval of 20 degrees when the levers of lock mechanism at both ends of the handle are pressed in the OPEN direction in order to unlock. The handle can be used as a carrying handle and a stand for observation.

The handle must be locked when it is not turned. If the handle is used as a carrying handle or a stand in unlock state, it may result in damage of the instrument.

Rubber feet and power cord winder which is used also as feet for stable vertical elevation setting of the instrument are mounted on the cover and the rear panel respectively. When using the cord winder as the feet, fully expand four slide feet (winder) outside. To set the slide feet to initial position, press them inside.

When using the instrument in vertical elevation setting, do not bring the instrument down by pulling a probe forcefully or striking with other devices or apparatus.

CONTROLS AND CONNECTORS

The major controls and connectors for operation of the SS-3510 are located on the front panel of the instrument. A few auxiliary functions are provided on the top cover and left and rear panels. Figs. 2-1 to 2-4 show the front panel, top cover, and left and rear panels respectively. A brief description of each control and connector is given here. More detailed operating information is given in later section "OPERATING INSTRUCTION".

The front panel is color-cordised with black for power supply and cathode-ray tube, green for vertical deflection system, blue for triggering and horizontal deflection system and indication of correct operation, yellow for magnification of deflection factor, and red for uncalibration.

Front Panel

INTEN

Controls brightness of the display.

FOCUS

Provides adjustment for optimum definition.

0.6V CAL

Terminal to provide a 0.6V sequare wave signal having a repetition rate of approximately 1 kHz.

DELAY

Provides variable sweep delay between 0.35 and 10.50 times the delay time set by the A TIME/DIV switch. This control allows two ranges for coarse and fine control.

POWER

Power line switch. Power is supplied to the instrument when this switch is turned on and the pilot light glows.

MODE

Selects the vertical mode of operation. The following modes can be selected.

CH1 : Displays Channel 1 only.

CH2 : Displays Channel 2 only.

ALT : Dual-trace display of signals on both channels. Display is switched between channels at the end of each sweep. Suitable for display of comparatively high frequency signals.

CHOP: Dual-trace display of signals on both channels. Display is switched between channels at an approximate repetition rate of 250 kHz. Suitable for display of comparatively low frequency signals.

ADD : Signals applied to the CH1 and CH2 input connectors are algebraically added and the sum is displayed on the CRT screen. The POLAR switch alows the display to be CH1 + CH2 or CH1 – CH2.

Fig. 2-1 Front panel

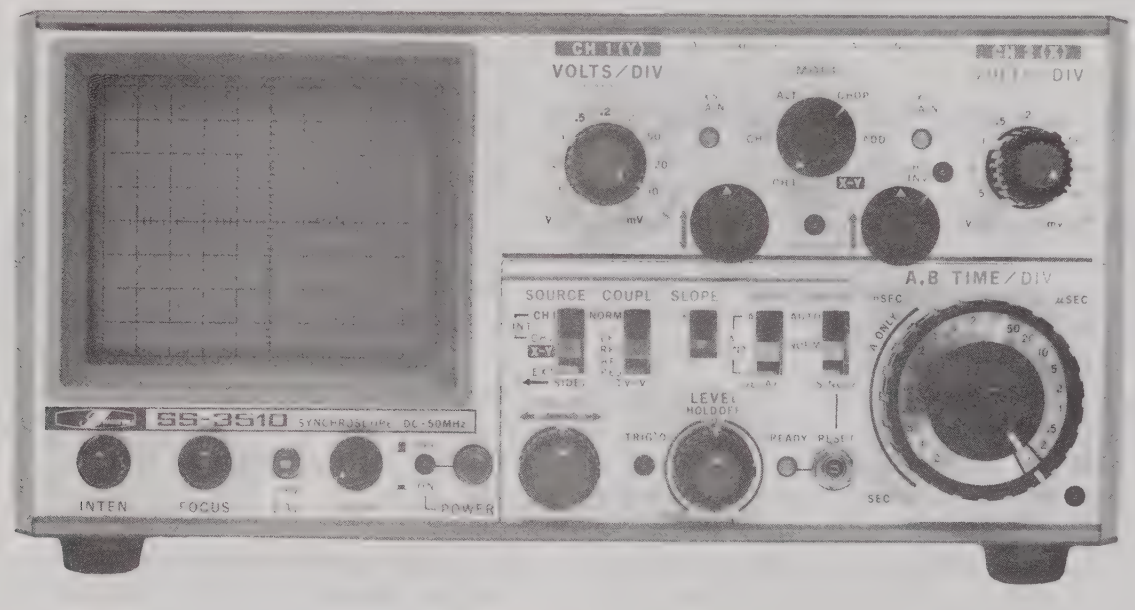
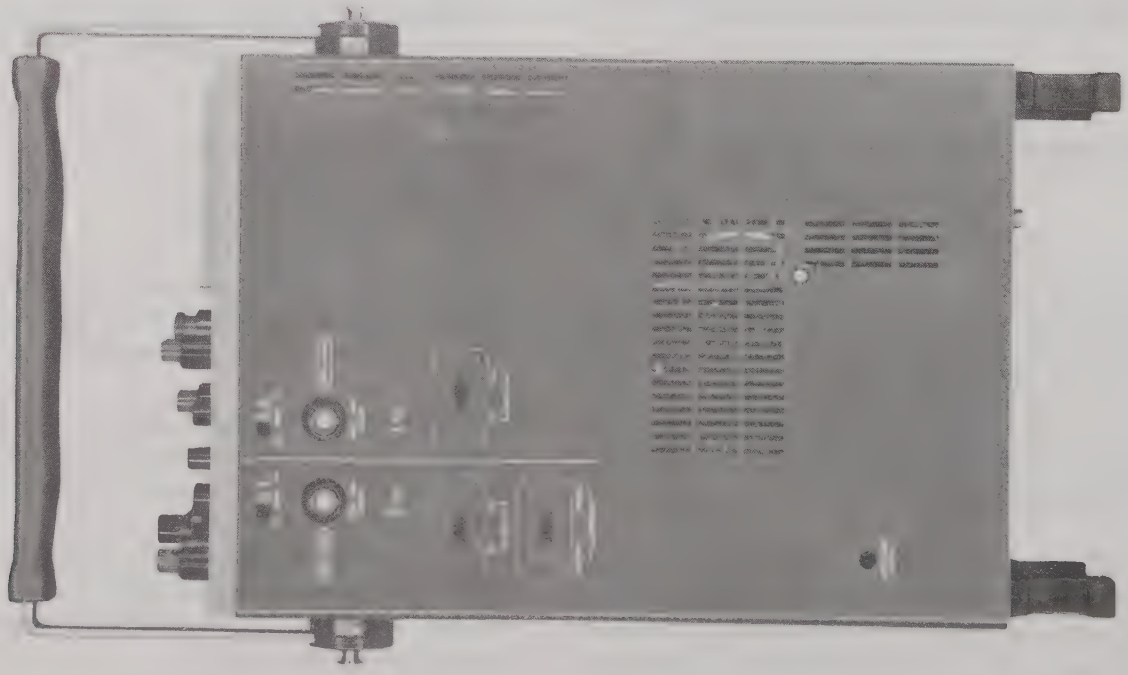


Fig. 2-2 Top cover



VOLTS/DIV (Black Knob)

Selects vertical deflection factor in a 1-2-5 sequence (the VARIABLE control must be in the CALIB position for the indicated deflection factor).

VARIABLE (Red knob)

Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.

X5 GAIN

Light indicates that the GAIN switch on the top cover is set to X5.

CH2 INV

Light indicates that the POLARITY switch on the top cover is set to INV.

Controls the vertical position of the display.

In the X-Y mode of operation, the Channel 1 Position control positions on the Y-axis and the Horizontal Position and its Fine controls position on the X-axis.

CH1 OR 2 UNCALIB

Light indicates that the VARIABLE control is not in the CALIB position. When the VARIABLE controls of both channels in the uncalibrated position, the brightness of the light intensifies by a factor of 2.

SOURCE

Selects source of trigger signal.

CH1 : A sample of the signal from the Channel 1 is used as a trigger signal.

CH2 (X-Y) : A sample of the signal from the Channel 2 is used as a trigger signal. For the X-Y operation, the SOURCE switch must be set to this position together with setting of the MODE switch.

EXT : Trigger signal is obtained from signal connected to the EXT TRIG IN connector on the left panel.

COUPL

Selects the following couplings between trigger signal and input of trigger circuit.

NORM: When the SOURCE switch is set to CH1 or CH2, AC coupling is provided. When the SOURCE switch is set to EXT, AC and DC couplings can be selected by the AC-DC switch on the left panel. The AC coupling rejects DC and attenuate signals below about 10 Hz. Signals above about 10 Hz pass. The DC coupling accepts all trigger signals from DC to 50 MHz or greater.

LF REJ: Rejects DC and attenuates signals below about 10 kHz. Accepts signals above about 10 kHz.

HF REJ (TV-V) : Accepts signals between 10 Hz and 10 kHz. DC is rejected and all signals outside the above range are attenuated. This coupling is also suitable for measurement of TV composite signal.

SLOPE

Selects the slope of the trigger signal which starts the sweep.

+ : Sweep can be triggered from the positive-going portion of the trigger signal.

– : Sweep can be triggered from the negative-going portion of the trigger signal.

DISP

Selects the horizontal display mode of operation. The following modes can be selected.

A : Horizontal deflection provided by A Sweep. Displayed sweep rate is determined by the A TIME/DIV switch. B Sweep inoperative.

A INT: In this mode, the displayed sweep rate is determined by the A TIME/DIV switch. The trace is intensified for the duration of the B sweep time. This switch position provides a check of the duration and position of the B sweep (delayed sweep) with respect to the delaying sweep.

B (DELAY): The portion intensified in the A INT mode is displayed on the full area of the CRT. The sweep rate is determined by the B TIME/DIV switch and the delay time is determined by the settings of the A TIME/DIV switch and the DELAY control.

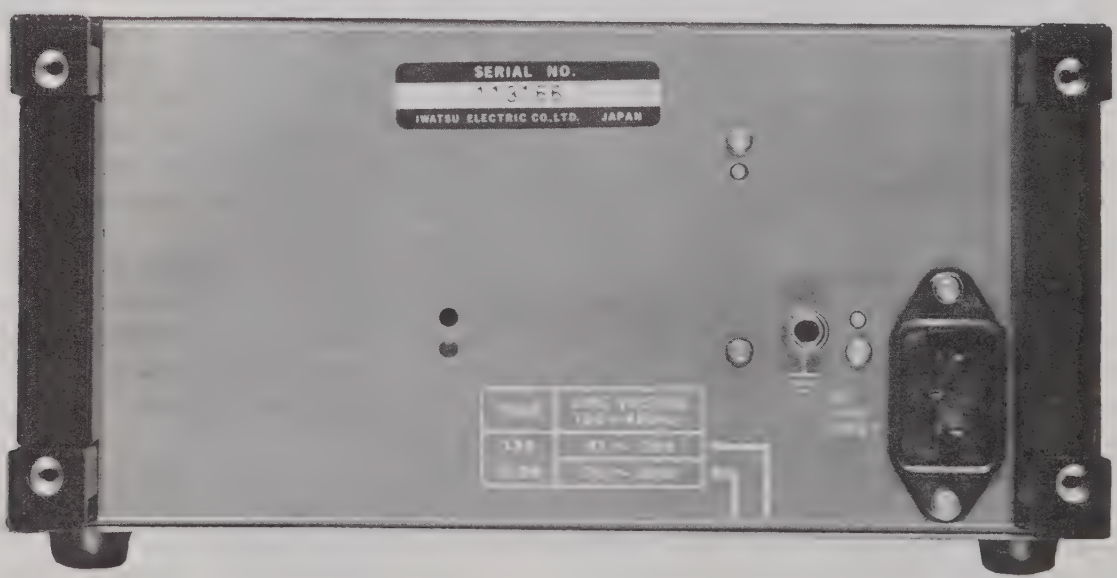
MODE

Selects the operating mode for the A sweep circuit. The following modes can be selected.

AUTO: A Sweep can be triggered by signals that have repetition rate above 50 Hz and are within the frequency range selected by the COUPL switch. When the LEVEL

Fig. 2-3 Left side panel

Fig. 2-4 Rear panel



control is turned to outside of the triggering range or no trigger signal is supplied to the trigger circuit, the sweep free-runs to produce a reference trace.

NORM: A Sweep can be triggered by signals that are within the frequency range selected by the COUPL switch. When the LEVEL control is turned to outside of the triggering range or no trigger signal is supplied to the trigger circuit, the sweep stops.

SINGLE: Single sweep mode.

⇦ ⇨ (Black knob)

Controls the horizontal position of the display.

⇦⇨ (PULL X10) (Red knob)

Finely controls the horizontal position of the display. This control functions also as the pull switch that increases the displayed sweep rate by a factor of 10.

TRIG'D

Light indicates that triggering is obtained correctly.

LEVEL

Selects the amplitude point on the trigger signal at which the sweep is triggered.

HOLDOFF

Provides controls of holdoff time between sweeps to obtain stable displays when triggering on a complicated pulse train such as complex digital words.

RESET

Pushbutton switch to ready the A Sweep to present a single sweep with receiving of an adequate trigger signal.

READY

Light indicates that the A Sweep is set to the ready state by the RESET button.

A, B TIME/DIV

A TIME/DIV switch (outer black knob) selects the sweep rate of the A Sweep and selects the basic delay time to be multiplied by setting of the DELAY control for delay-sweep operation. A VARIABLE control must be set to the CALIB position for calibrated A sweep rate and calibrated delay time.

B TIME/DIV switch (inner black knob) selects the sweep rate of the B Sweep for delay-sweep operation only.

A UNCALIB

Light indicates that the A VARIABLE control is not in the CALIB position.

Top Cover

AC-GND-DC

Selects the following signal input coupling.

AC: Signal is capacitively coupled to the Vertical Amplifier. DC component of signal is blocked. Low-frequency limit (low −3 dB point) is about 4 Hz.

GND : Input signal is removed from the input of the Vertical Amplifier and the input is grounded. Does not ground the input signal.

DC : All components of the input signal are passed to the Vertical Amplifier.

INPUT

Input connector for deflection signals.

GAIN

Changes gain of the Vertical Amplifier. In the X1 position, deflection factor is set to the values indicated by the VOLTS/DIV switch. In the X5 position, the deflection factor is increased by a factor of 5.

POLAR

Switch to change polarity of the Channel 2 display. Setting the switch to NORM allows normal polarity and setting it to INV permits inverted polarity.

TRACE ROTATION

Variable rasistor adjusting traces to the graticule in parallel.

Reft Side Panel

Z AXIS INPUT

Input connector for intensity modulation signal of the display.

A VARIABLE

Provides continuously variable A sweep rates between the calibrated settings of the A TIME/DIV switch.

B SWEEP

Selects the mode to start the B sweep (delayed sweep) when in the A INT or B position of the DISP switch. In the AUTO position, B sweep starts immediately after the delay time set by the DELAY control and the A TIME/DIV switch. In the TRIG position, the B Sweep circuit is armed after the delay time and B Sweep must be triggered by a trigger signal.

EXT TRIG IN

Input connector for an external trigger signal.

AC-DC

Select the couplings between external trigger signal and input of trigger circuit when the COUPL switch on the front panel is set to NORM. When the COUPL switch is set to HF REJ (TV-V), this switch does not function and the HF REJ (TV-V) coupling is provided.

Rear Panel

Regulating Range Table

The table shows two regulating range of the instrument. These ranges are selected by the 100V—200V switch (S1102) mounted on the internal bottom circuit board. Setting position of the switch can be confirmed from the ventilation hole of the bottom cover.

⏚

Ground terminal.

AC LINE INPUT

Connector for power cord.

OPERATING INSTRUCTION

Precautions

Ambient Temperature and Air Ventilation

The ambient temperature range of this instrument for normal operation is from −10°C to +50°C. The use of this instrument with the temperature exceeding this range may result in trouble; therefore, the operation in this range is essential. Moreover, do not place other devices or apparatus on the ventilation hole of the cover in order to improve the efficiency of the heat radiation.

Use Three-Core Power Source

In order to protect the user and instrument from dangerous troubles, use a three-core power source. If a two-core source is compelled to use, connect the power cord using the accessory 3-2 adapter and make the earth connection of the instrument with the ground terminal on the rear panel.

Fig. 2-5 Voltage range table

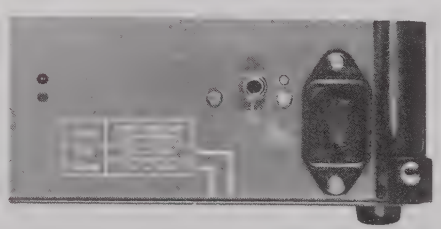
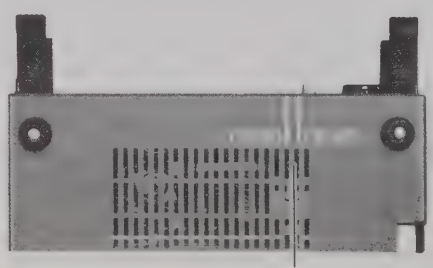


Fig. 2-6 100V-200V switch (bottom)



Check Line Voltage

A desired operating voltage can be selected from two voltage ranges, 100 V AC (regulating range : 85 to 130 V) and 200 V AC (regulating range : 170 to 260 V) by the 100V-200V switch mounted on the internal bottom. Setting position of the switch can be confirmed from the ventilation hole of the bottom cover. Check the line voltage, and confirm that the range selected by the 100V-200V switch covers the line voltage. Note that mis-using may result in trouble of the instrument.

Do not Intensify Unnessarily

The brightness of the spots or traces on the viewing area must not be increased excessively. Excessively intensified spots or traces may irritate an operator. If such spots or traces are stopped at the same position for a long time, it may result in burning of the phosphorescence coating of the CRT.

Do not Apply an Excessively High Input Voltage

The rated maximum allowable input voltage for each input connector is as follows. Observe this restriction on voltage.

INPUT	250V (DC + Peak AC)
Input of probe	600V (DC + Peak AC)
EXT TRIG IN	250V (DC + Peak AC)
Z AXIS INPUT	50V (DC + Peak AC)

Basic Operation

Turn-on Procedure

After the following operation, setting the POWER switch to on allows the Channel 1 trace to appear after approximately 15 seconds.

1. After confirming the line voltage and the regulating range, turn off the POWER switch and connect the power cord.
2. Set the controls as follows.

INTEN	Mid-position
MODE (vertical)	CH1
CH1 Position	Mid-position
DISP	A
MODE (Sweep)	AUTO
Horizontal Position	Mid-position

Focusing

After the following operation, adjusting the FOCUS control makes the trace line thin and clear.

1. Shift the trace to the center on the viewing area by the CH1 Position control.
2. Set the A TIME/DIV switch to 1mSEC.
3. Set brightness of the trace to desired degree by the INTEN control.

Triggering by Signal Apply

After the aforesaid operation, the following operation allows most ordinary type triggering (AUTO operation by internal triggering and AC coupling).

1. Set the controls as follows:

SOURCE	CH1
COUPL	NORM
CH1 VOLTS/DIV	10mV
CH1 VARIABLE	CALIB
CH1 AC-GND-DC	DC

2. Connect the 0.6V CAL signal to the CH1 INPUT connector using the accessory X10 probe.
3. Set the LEVEL control to the mid-position.

The above-mentioned operation allows the triggering, and a 6 division calibration voltage waveform is displayed on the viewing area. For details of triggering, refer to the later section "Triggering".

Obtaining the Spot

After the aforesaid operation, setting the CH1 AC-GND-DC switch to GND, the sweep MODE switch to NORM and the INTENSITY control to the fully clockwise position allows a spot to appear.

Single-Trace and Dual-Trace

Setting the vertical MODE switch to CH1 or CH2 allows the single-trace display of Channel 1 or Channel 2 respectively.

There are two types of dual-trace modes: ALT (alternate display) and CHOP (chopped display). These modes can be selected with the vertical MODE switch. By properly selecting these modes, dual-trace display can be performed for phenomena over a wide range from low speed up to

high speed.

Dual-Trace Display by ALT

Setting the vertical MODE switch to ALT allows the sweep of Channel 1 and Channel 2 to be effected alternately. When the two signals to be measured are applied to both input connectors, the dual-trace measurement can be accomplished.

Alternate display covers whole range of the TIME/DIV setting values, but when the sweep speed is very slow, two phenomena cannot be displayed at the same time because the sweeps are performed alternately. In the case of low speed signals of which measurement is effected with the TIME/DIV switch at the 2 mSEC or slower position, use the CHOP mode which will be explained below.

Dual-Trace Display by CHOP

The CHOP mode allows two phenomena to be displayed at the same time even if the sweep speed is slow. However, the chopped sweep is not suitable for high sweep speed operation. Since the Channel 1 and Channel 2 in the CHOP mode is switched at an approximate repetition rate of 250 kHz, high sweep speed (when the TIME/DIV switch is set to approximately 20 μSEC or faster position) permits the trace to be displayed as a dotted line which is not easy for measurement. In such case, use the ALT mode.

In the CHOP mode, setting the AC-HF REJ-DC switch to HF REJ allows more stable triggering.

Added Display

The added display mode can be selected by setting the vertical MODE switch to ADD. In the ADD mode, signals applied to the CH1(Y) and CH2(X) INPUT connectors are algebraically added and the sum is displayed on the CRT. Setting the POLAR switch to the out or in position allows the display of CH1 + CH2 or CH1 – CH2 respectively.

Precautions for Added Display

1. When the added display is made in differential input (the INV position of the POLAR switch), set the AC-GND-DC switches of both channels to the same positions.
2. The Position controls of both channels allow the shift of the trace position. For correct measurement, set the Position controls to each mid-range.

Signal Application

The signal to be measured is applied to the INPUT connectors of Channel 1 and Channel 2. A probe is generally used as the means to connect the signal source with the input connector.

The probes can protect the signal to be measured from the interference caused by the external electrical field. The 10 : 1 probes increase the input impedance and decrease the load effect to the signal source. So that, signals from higher output impedance sources and at higher frequencies can be correctly measured with the probes. As the 10 : 1 probes attenuate the signal to 1/10, the value indicated by the VOLTS/DIV switch must be multiplied by 10.

The 1 : 1 probes do not attenuate low frequency signals, and is convenient to low frequency signal measurement. However, using the 1 : 1 probe increases the input impedance and gives bigger load effect to a high frequency signal.

For the details,see the instruction manuals of the probes.

Signal Input Coupling

Many kinds of signals are measured; DC, AC and mixed signals. To measure these signals correctly, an adequate signal input coupling must be selected with the AC-GND-DC switch.

This switch selects the input coupling mode of the vertical deflection system. In the AC coupling, the input connector and the input of the vertical amplifier are connected with a capacitor, in the DC coupling, they are connected directly, and in the GND mode, they are disconnected together and the input of the vertical amplifier is grounded.

In the AC coupling, the capacitor blocks the DC component of the signal and the displayed signal can be magnified without being deflected outside of the viewing area by the DC component. The AC coupling, however, produces sags in low frequency square waves, or displays the decreased amplitude of sine waves. The amplitude decreases approximately 3 dB at 4 Hz. The DC coupling passes all compo-

nents of the signal. The DC coupling is generally used if the DC component is need not to be blocked.

In the GND mode, the input of the vertical amplifier is grounded, and the ground level is traced on the viewing area. The level is used as the reference level in measurements.

Deflection Factor

For accurate measurement of signal waveforms, it is essential to display adequate amplitude of the waveforms on the viewing area. An excessively small or large signal compared with the viewing area enables no adequate measurement. If the signal to be measured is small, it need to be amplified, and if large, need to be attenuated.

The deflection factor is selected by the GAIN and VOLTS/DIV switches and finely adjusted by the VARIABLE control. Each deflection factor becomes equal to the value indicated by the VOLTS/DIV switch when the GAIN switch is set to x1 and the VARIABLE control is set to the fully clockwise position. When the GAIN switch is set to x5, each deflection factor is increased by a factor of 5. The values show the voltage for one division on the viewing area. The deflection factor is decreased when the VARIABLE control is turned counterclockwise and becomes less than 1/2.5 of each indicated value at the fully counterclockwise position.

Triggering

In order to obtain triggering, the followings must be correctly selected: trigger source, internal trigger signal, trigger coupling, sweep mode and trigger level, and trigger slope. The above five items are described in detail at first, then brief operating procedures will be explained.

Trigger Source

In order to observe the input signal waveform on the viewing area by triggering, the input signal itself or a signal having an integer relationship with respect to the input signal in frequency (which is called a trigger signal) must be supplied to the trigger circuit in order to actuate the trigger generator which sends a trigger pulses and conducts the horizontal sweeping of display.

Setting the SOURCE switch to CH1 or CH2 allows internal triggering which uses a sample of the signal from the channel selected by this switch as a trigger signal. Setting the SOURCE switch to EXT permits external triggering. In this case, the trigger signal is obtained from signal connected to the EXT TRIG IN connector.

In the internal triggering, adequate amplitude of trigger signal is obtained by connecting the signal to be measured to the INPUT connector and selecting the deflection factor because the trigger signal is supplied from the vertical deflection system to the trigger circuit. Therefore, triggering can be obtained even if the input signal is comparatively small.

The external triggering offers the following unique features.

First, the external triggering is free from influence of vertical deflection settings. In the internal triggering, as changing the deflection factor allows trigger signal amplitude to vary, readjustment of the LEVEL control is often required to resume proper triggering level. On the other hand, the external triggering needs no readjustment of the LEVEL control against any changing of deflection factor so long as the external trigger signal amplitude is retained unchanged.

Second, when it is desired to start the sweep a certain time before or after the input signal, the desired waveform can be displayed by using a signal of such timing as external trigger signal, provided such signal is available.

Internal Trigger Signal

Selection of the CH1 and CH2 trigger signals with the SOURCE switch can be made in any mode other than X-Y of the vertical MODE switch. Therefore, in the single-trace operation, generally, select the same channel as the channel to which the signal to be measured is connected, with the SOURCE switch. Besides, in the single-trace operation, connecting the signal to be displayed to one channel and selecting its channel with the vertical MODE switch, and connecting the signal to be used as an external trigger signal to other channel and selecting its channel with the SOURCE switch allows a triggering as a kind of external triggering. In this triggering method, it is featured that the trigger signal can be easily observed and its amplitude can

be adjusted by the VOLTS/DIV switch and the VARIABLE control.

In the dual-trace operation, when the input signal frequencies are the same, selecting the channel to which the signal of higher amplitude and lesser noise component is applied allows stable triggering. When the input signal frequencies differ from each other (but, there is no phase shift between these signals), the one of the lower frequency should be used as the trigger signal. If the other signal having the higher frequency is used as the trigger signal, the one of the lower frequency signal is displayed in duplication. When the dual-trace display is intended for measurement of phase difference between two signals, the one with the leading phase must be selected as the trigger signal.

Trigger Coupling

The COUPL switch is designed to select the coupling mode between trigger signal and the trigger circuit. Three coupling modes are available: AC coupling, coupling by a low pass filter (HF REJ) and DC coupling.

These couplings are selected to obtain stable triggering in accordance with the kind of trigger signals. e.g., DC signals, AC signals, AC signals superimposed on DC and signals superimposed by high frequency noise.

NORM: When the COUPL switch is set to NORM, in the internal triggering, the AC coupling is provided, and in the external triggering, selection of the AC and DC couplings can be made with the AC-DC switch on the left panel.

The AC coupling passes the trigger signal to the trigger circuit through a capacitor, therefore DC and a low frequency component are rejected and attenuated respectively. Signals above about 10 Hz pass. This coupling is advantageous for ordinal signal measurements as the triggering is free from DC, but the triggering is difficult when the trigger signal frequency is below about 10 Hz. The DC coupling passes all trigger signals to the trigger circuit, so the triggering is possible from DC.

LF REJ: When the COUPL switch is set to LF REJ, the LF REJ coupling is provided regardless of settings of the SOURCE and AC-DC switches. In this coupling, the trigger signal is supplied to the trigger circuit through a high pass filter which passes signals above about 10 kHz. Therefore, this coupling is advantageous for measurement of signals containing low frequency noise.

HF REJ (TV-V): When the COUPL switch is set to HF REJ (TV-V), the HF REJ (TV-V) coupling is provided regardless of settings of the SOURCE and AC-DC switches. In this coupling, the trigger signal is supplied to the trigger circuit through a low pass filter which passes signals between 10 Hz and 10 kHz. Therefore, this coupling is advantageous for measurement of signals containing high frequency noise. This coupling also gives stable triggering for measurement of TV composite video signal as the video signal portion is attenuated and the sync signal portion alone is passed in this coupling.

Sweep Mode and Trigger Level

Two sweep modes, AUTO and NORM, can be selected by the sweep MODE switch. Each mode has the following features, so use one mode which is suitable for measurement object.

In both modes, triggering is obtained in a certain range from the center of the LEVEL control and the range width varies according to the trigger signal amplitude.

In the AUTO mode, free-running sweep occurs when triggering is not accomplished, in other word, the LEVEL control is set to outside of the triggering range or no trigger signal is supplied to the trigger circuit. So, the trace of ground level is provided by setting the AC-GND-DC switch to GND. Triggering, however, is not obtained in signals below 50 Hz. In such case, use the NORM mode.

In the NORM mode, the triggering is possible from DC, but the sweep stops when the triggering is not obtained.

Trigger Slope

The slope of the trigger signal which starts the sweep is selected with the SLOPE switch. In the + and – positions of the switch, sweep can be triggered from the positive-going and negative-gaing portions of the trigger signal respectively.

Holdoff Time

When the input signal has a complicated pulse train, the pulse train may be displayed in duplication in a certain sweep rate even if the triggering is obtained correctly.

In such case, using the HOLDOFF control is useful. The

duplication can be eliminated by turning the HOLDOFF control slightly clockwise from the fully counterclockwise position.

Triggering Procedure I [Internal Triggering]

1. Select the CH1 or CH2 trigger signal with the SOURCE switch.
2. Select the NORM (AC) or HF REJ (TV-V) coupling with the COUPL switch.
3. Select the AUTO or NORM mode with the sweep MODE switch.
4. Set the display amplitude to a value higher than rating. (See Table 1-1.)
5. Select a slope of trigger signal to set trigger level with the SLOPE switch.
6. Adjust the LEVEL control.

Triggering Procedure II [External Triggering]

1. Set the SOURCE switch to EXT.
2. Connect an external trigger signal to the EXT TRIG IN connector. (See Table 1-1.)
3. Select a trigger coupling with the COUPL and AC-DC switches.
4. Select the AUTO or NORM mode with the sweep MODE switch.
5. Select a slope of trigger signal with the SLOPE switch.
6. Adjust the LEVEL control.

Sweep Rate

The signals to be measured varies in many ways, from high to low repetition frequencies, or from fast to slow rise time pulses. In order to measure such signals, a suitable sweep rate must be selected according to the repetition frequencies or the rise time.

The sweep rate of the A Sweep is selected by the A TIME/DIV switch. Each setting value is slowed down when turning the A VARIABLE control counterclockwise and set less than 1/2.5 of the value at the fully clockwise position, CALIB.

The sweep rate of the B Sweep is always calibrated to the value indicated by the B TIME/DIV switch as no variable control is presented.

Sweep Magnifying

A part of the input waveform can be magnified with regard to time by the use of faster sweep rate. However, the part which is far from the sweep start position may be out of the viewing area when the sweep rate is increased.

The part to be measured can be magnified 10 times by shifting its part to the center of the viewing area with the Horizontal Position control and then pulling the (PULL x10) switch. Entire length of the trace is magnified to approximately 100 division wide though only the center 10 division part is displayed in the viewing area. The magnified trace can be fully observed by sequentially adjusting the Horizontal Position and its Fine Position controls.

The sweep rate at 10 magnification can be calculated by multiplying the TIME/DIV setting value by 1/10. Therefore, the available maximum sweep rate can be obtained by the following calculation: 100ns/div (the maximum sweep rate at no magnification) x1/10 = 10ns/div.

Delay Sweep

The above mentioned magnification of display is simple in operation and useful to obtain the faster maximum sweep rate than the setting value of the TIME/DIV switch by 10 times. However, the magnification factor is limited to 10 times. In the case of sweep magnification by the delay operation, the limitation of magnification factor can be enlarged to an extent determined by the ratio of A sweep rate to B sweep rate.

Note that the magnification by the delay operation has a limitation by applicable input signal frequencies. In other words, if the input signal frequency is so high that the A TIME/DIV switch is set to the highest speed position before magnification, no further magnification is obtainable. It shoud be understood that the sweep magnification by the dealy is very useful for magnifying an arbitrary portion of comparatively low frequency signals.

The magnification by the delay includes the following two modes: automatic sweep and triggered sweep.

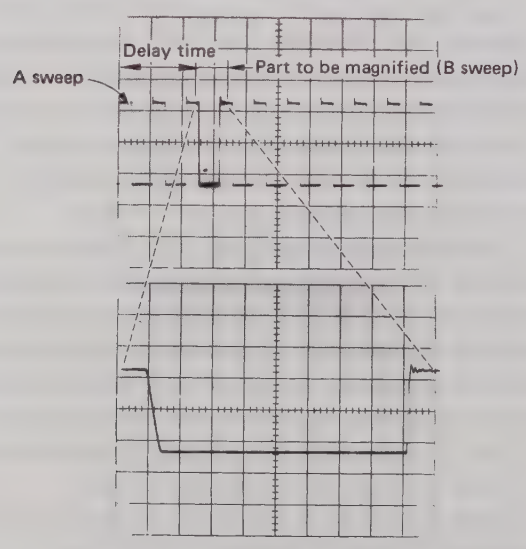
Automatic Sweep

The operating procedures are as follows:

1. Set the DISP switch to A.
2. Apply the signal to be measured to the INPUT connector and obtain triggering for the input signal.
3. Decrease the brightness of the trace a little.
4. Set the B TIME/DIV switch to a position which is high than that of the A TIME/DIV switch.
5. Set the B SWEEP switch to AUTO.
6. Set the DISP switch to A INT.

After the aforesaid procedure, turning the DELAY clockwise allows an intensified part to appear as shown in Fig. 2-7 and to shift rightward continuously. When the intensified part is shifted to the position to be magnified, setting the DISP switch to B permits the part to be magnigied fully on the viewing area. The sweep rate of the B sweep is determined by the B TIME/DIV switch. Making the higher sweep rate gives higher magnification factor, but excessive high magnification factor causes a delay jitter. Therefore, the magnification by the automatic sweep is limited by the delay jitter. However, the magnification factor can be more increased by the triggered sweep which will be described later.

Fig. 2-7 Magnification by automatic delay sweep



The delay time for the magnified part can be obtained in the A INT sweep as follows:

Delay time(s) = [Distance between start points of A sweep and intensified part (div)] x [Setting value by A TIME/DIV (s/div)]

The DELAY control has a variable resistor covering coarse and fine adjustment. Turn this control so that the intensified part may a little overrun the part to be magnified, and turn the control slowly in the reverse direction. Then, in a certain turning range, this control functions as a fine adjustment knob to select the magnified part accurately.

Triggered Sweep

Setting the B SWEEP switch to TRIG allows the triggered sweep. The magnified part can be displayed by the same procedure as that of the above-mentioned automatic sweep.

Magnified part (B Sweep) in the triggered sweep starts at a preset triggering point for B Sweep after the delay time is given by the DELAY control. By turning the DELAY control, the intensified part (to be magnified) jumps from rising edge to the rising edge of the A Sweep waveform. The jumping can occur at each falling edge of the signal when the SLOPE switch is set to —. When the B SWEEP switch is set to TRIG and the DISP switch is set to B, turning the DELAY control causes no shift of the displayed waveform on the viewing area; however, the displayed waveform in this case is the part selected in the A INT Sweep.

Single Sweep

Many transient effect are seen in daily service such as chattering of relay contact or discharging waveform. Such transients can be observed correctly by using the single sweep function in which sweeping of display takes place only once when triggered and by photographic recording.

In this section, the basic operation for the single sweep will be described assuming that calibration voltage output is supplied to the input.

1. Set the DISP switch to A and the sweep MODE switch to NORM.

2. Connect the 0.6V CAL signal to the INPUT connector using a probe, and obtain positive triggering after selecting a optimum deflection factor and sweep rate.
3. Set the sweep MODE switch to SINGLE, and push the RESET button in order to check that the sweep is made only once.
4. Set the AC-GND-DC switch to GND and push the RESET button again in order to check that the READY indicator is lightened.

When the above-mentioned procedure allows the indicator to go on, the ready state (the state which offers only one sweep by a trigger signal) is obtained. In this state, if a transient effect is applied to the signal input connector, the transisent effect is displayed correctly with the only one sweep.

Also in external triggering, this single sweep is available if the external trigger signal has roughly the same operation as that for the calibration voltage output given in item 4 above.

The single sweep is impossible for the simultaneous dual trace in the alternate sweep, but it is possible in the chopped sweep.

X-Y Operation

The X-Y scope operation gives phase difference measurement, hysteresis loop observation, etc.

This instrument can be used as an X-Y scope by setting the vertical MODE switch to X-Y and the SOURCE switch to CH2 (X-Y). A spot appears at the mid-position of the trace. Applying signals to the INPUT connectors of Channel 1 and Channel 2 allows the Channel 1 signal to drive the Y-axis and the Channel 2 to drive the X-axis respectively in order to display a Lissajou's pattern.

The deflection factors of the Y-axis and X-axis are determined by the VOLTS/DIV switches and the VARIABLE controls of Channel 1 and Channel 2 respectively. The display can be shifted vertically and horizontally by the Channel 1 Position control and the Horizontal Position and its Fine controls respectively.

NOTES

SECTION 3
MEASURING INSTRUCTION

Probe Phase Adjustment

Proper adjustment of the probe phasing is required before measurements as the incorrect phasing results in erroneous measurements when the 10:1 probe is used.

1. Set the controls as follows:

VOLTS/DIV	10mV
VARIABLE	CALIB
TIME/DIV	0.5 mSEC
VARIABLE	CALIB
(PULL x10)	Pushed state

2. Connect the probe between the input connector and the CAL 0.6V terminal.
3. Display the calibration voltage waveform with six division amplitude.
4. Adjust the variable capacitor of the probe (located in a hole of the input connector side) using the accessory adjustment driver, and set the top of the waveform to the correct phasing shown in Fig. 3-1.

Voltage Measurement

Quantitative Measurement

The quantitative measurement of voltage can be made by setting the VOLTS/DIV VARIABLE control to the CALIB position. The measured value can be calculated by Equation (1) or (2).

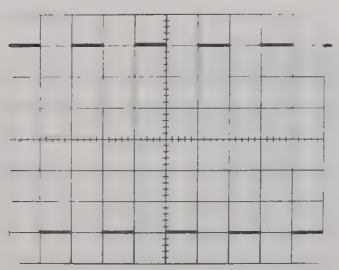
a. Measurement with the x1 position of the probe:
   Voltage (V) = VOLTS/DIV setting value (V/div) x Displayed amplitude of input signal (div) . . . (1)
b. Measurement with the x10 position of the proble:
   Voltage (V) = VOLTS/DIV setting value (V/div) x Displayed amplitude of input signal (div) x10 . .(2)

DC Voltage Measurement

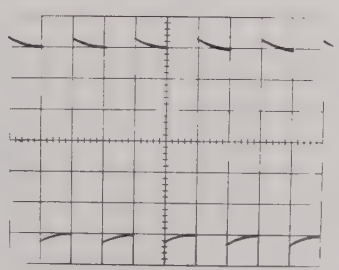
This instrument functions as a high input resistance, high sensitivity, quick response DC volt meter in order to measure DC voltage. Measurement procedure is as follows:

1. Set the sweep MODE switch to AUTO, and select a sweep rate so that the trace may not flicker.
2. Set the AC-GND-DC switch to GND. The vertical position of the trace in this case is used as 0-volt reference line as shown in Fig. 3-2. Adjust the vertical POSITION control in order to place the trace exactly on a horizontal graticule, which facilitates the reading of signal voltage.
3. Set the AC-GND-DC switch to DC, and apply the voltage to be measured to the input connector. The vertical

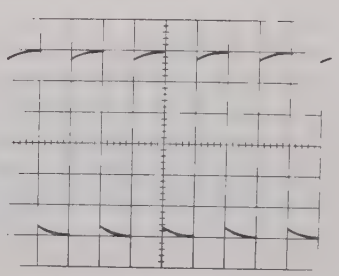
Fig. 3-1 Phasing of probe and displayed waveform



Correct Compensation



Excessive Compensation



Insufficent Compensation

diaplacement of the trace gives the voltage amplitude of the signal. When the trace shifts upward, the measured voltage is positive with regard to the ground potential. When the trace shifts downward, the voltage is negative. The voltage can be obtained by Equation (1) or (2).

AC Voltage Measurement

The measurement of the voltage waveform is performed as follows: Set the VOLT/DIV switch in order to obtain the amplitude for easy reading, read the amplitude as shown in Fig. 3-3, and calculate by Equation (1) or (2).

When the waveform superimposed on DC current is measured, set the AC-GND-DC switch to DC in order to measure the value including DC component, or set this switch to AC in order to measure AC component only.

The measured value by means of this procedure is peak value (Vp-p). Effective value (Vrms) of a sine wave signal can be given by Equation (3).

$$\text{Effective voltage (Vrms)} = \frac{\text{Peak voltage (Vp-p)}}{2\sqrt{2}} \quad \ldots\ldots(3)$$

Time Measurement

The time interval of two points on a signal waveform can be calculated as follows: Set the TIME/DIV VARIABLE control to CALIB, read the setting values of the TIME/DIV and x5 MAG switches and calculate the time by Equation (4).

Time (s) = TIME/DIV setting value (s/div)
x Length corresponding to the time to be measured (div)
x Reciprocal number of x5 MAG setting value ..... (4)

Where, the reciprocal number of the x5 MAG setting

Fig. 3-2 DC voltage measurement

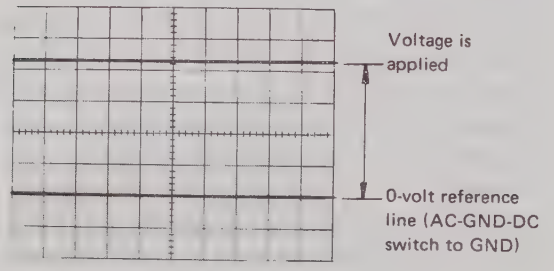


Fig. 3-3 AC voltage measurement

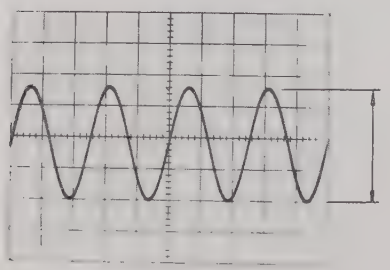


Fig. 3-4 Pulsewidth measurement

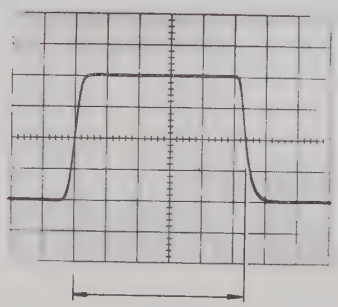
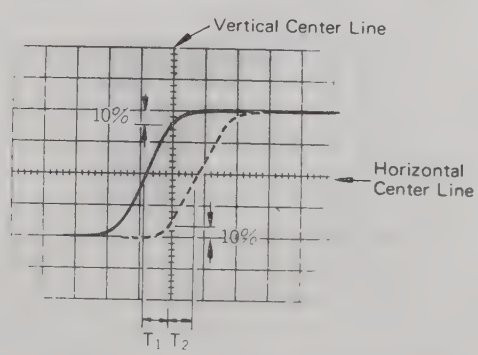


Fig. 3-5 Rise (or fall) time measurement



value is 1 when the sweep is not magnified, and 1/5 when the sweep is magnified.

Pulsewidth Measurement

The basic pulsewidth measurement procedure is as follows:

1. Display the pulse waveform vertically so that the distance between the top part of the pulse waveform and the horizontal center line of the graticule may be equal to the distance between the bottom part of the pulse and the horizontal center line as shown in Fig. 3-4.
2. Set the TIME/DIV switch in order to make the easy observation of the signal.
3. Read the distance between the centers of rising and falling edges, i.e., the distance between two points at which pulse endges cross the horizontal center line of the graticule. Calculate the pulsewidth by Equation (4).

Rise (or Fall) Time Measurement

The rise (or fall) time measurement of the pulses is obtained as follows.

1. Display the pulse waveform vertically and horizontally in the same manner as for the pulsewidth measurement procedure.
2. Turn the horizontal POSITION control in order to set the upper 10% point of the waveform on the vertical center line of the graticule. (In Fig. 3-5, the upper 10% point is 0.4 division below the top of the pulse since the displayed amplitude is 4 divisions.) Read the distance T_1 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
3. Shift and set the lower 10% point of the waveform to the vertical center line of the graticule as shown by the dotted line in Fig. 3-5. Read the distance T_2 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
4. Calculate the rise (or fall) time by substituting the sum of T_1 and T_2 for Equation (4).

Frequency Measurement

Of the frequency measurement procedure, there are the following methods.

The first method: Calculate the one-cycle time (interval) of the input signal by Equation (4) as shown in Fig. 3-6, and obtain the frequency by Equation (5).

$$\text{Frequency (Hz)} = \frac{1 \text{ (c)}}{\text{Period (s)}} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

The second method: Count the repetition number N per 10 divisions in the viewing area, and calculate the frequency by Equation (6).

$$\text{Frequency (Hz)} = \frac{N \text{ (c)}}{\text{TIME/DIV setting value (s/div)} \times 10 \text{ (div)}} \quad \ldots (6)$$

When N is large (30 to 50), the second method can give a higher accuracy level than that obtained with the first method. This accuracy is approximately equal to the rated accuracy of sweep rate. However, when N is small, the

Fig. 3-6 Frequency measurement (1)

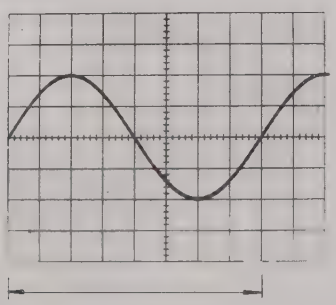
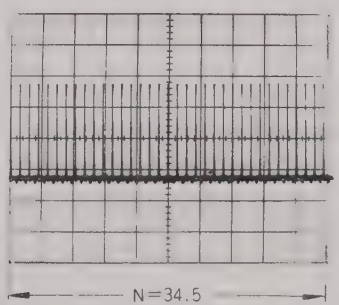


Fig. 3-7 Frequency measurement (2)



count below decimal point becomes very ambiguous, which results in considerable error.

For the measurement of comparatively low frequencies having a simple pattern such as sine wave, square wave, triangle wave, and sawtooth wave, measurement with high accuracy can be effected by the following method: Operate the oscilloscope as an X-Y scope, make the Lissajou's pattern by applying the signal of which frequency is known, and read the necessary value.

Phase Mearsurement

Of the measurement of phase difference between two signals, there are the following two methods:

The first one is the Lissajou's pattern method by using the instrument as an X-Y scope. The phase difference of signals can be calculated form the amplitudes A and B of the pattern shown in Fig. 3-8 and by Equation (7).

$$\text{Phase difference (deg)} = \sin^{-1}\frac{A}{B} \quad \ldots\ldots\ldots (7)$$

The second method is an application of dual-trace function. Fig. 3-9 shows an example of dual-trace display of leading and lagging sine wave signals having the same frequency. In this case, the SOURCE switch must be set to a channel which is connected to the leading signal, and set the TIME/DIV switch so that the length of 1-cycle of the dispalyed sine wave may be 9 divisions.

Then, 1-division graticule represents a waveform phase of 40° (1 cycle = 2π = 360°). The phase difference between the two signals can be easily calculated by Equation (8).

$$\text{Phase difference (deg)} = T\ (\text{div}) \times 40^\circ \quad \ldots\ldots\ldots (8)$$

Where, T is the distance between two points at which the leading and lagging signals cross the horizontal center line of the graticule.

Fig. 3-8 Phase difference measurement using Lissajou's pattern

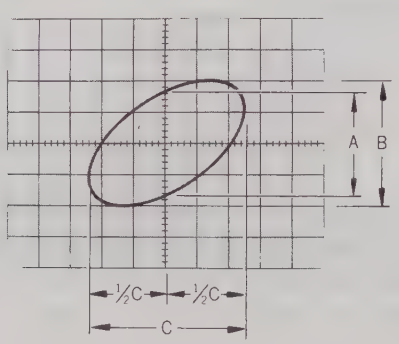
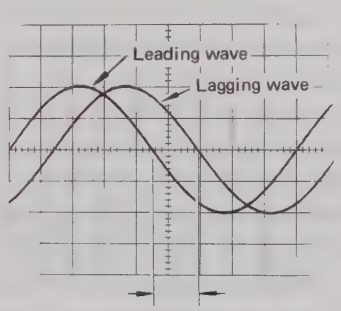


Fig. 3-9 Phase difference measurement by dual-trace display



SECTION 4
OPERATING PRINCIPLE

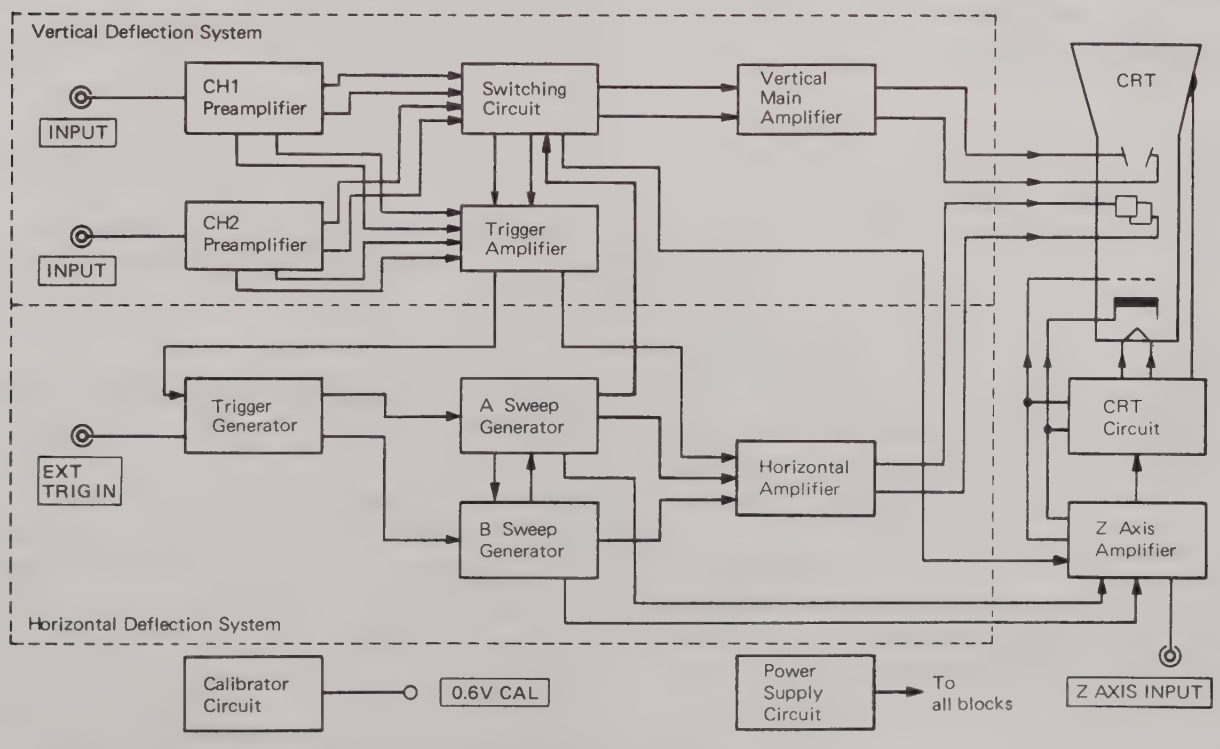
An overall block diagram of the SS-5510 is shown in Fig. 4-1.

The Vertical Deflection System contains two independent Preamplifiers. Signals to be displayed on the CRT are applied to either the Channel 1 and/or Channel 2 input connectors, converted into a push-pull output signal and amplified and connected to the Switching circuit.

The vertical MODE switch selects following five modes; Either Channel 1 or Channel 2 alone, the two signals electronically switched (ALT or CHOP), or the algebraic sum (ADD) or difference of the two signals. In the ALT mode, the Switching circuit are driven by a alternate signal supplied from the A Sweep Generator, resulting in an alternate display of the Channel 1 and Channel 2 signals as complete sweeps. In the CHOP mode, the chop multi circuit of the Switching circuit oscillates on a free-running basis at a repetition rate of approximately 250 kHz which switches the diode switching circuits causing the output signals from the two channels to be chop-displayed at a repetition rate of approximately 250 kHz regardless of the sweep rate. In this mode, the chop blanking signal is supplied to the Z Axis Amplifier to blank the transients of the switching action.

The input signal is also supplied from each trigger pickoff circuit of the Preamplifiers to the Trigger Amplifier where it is amplified and supplied to the Trigger Generator.

Fig. 4-1 Block diagram



The Vertical Main Amplifier provides the final amplification and deflect the beam vertically in the CRT.

The Trigger Generator circuit converts trigger signal into first-rise trigger pulses which initiate the sawtooth signals produced by the A or B Sweep Generator circuit.

The A Sweep Generator circuit produces a linear sawtooth signal of which the slope is determined by the A TIME/DIV switch. The output of the A Sweep Generator is connected to the B Sweep Generator to provide the delayed sweep. The slope of the B sawtooth signal is determined by the B TIME/DIV switch. The A and B Sweep Generators also produce unblanking gate signals to unblank the CRT.

The Horizontal Amplifier provides the amplification of the sawtooth signals or the X-axis signal in the X-Y mode and deflects the beam horizontally in the CRT.

The Z Axis Amplifier circuit determines the CRT intensity and blanking. This circuit sums current inputs from the INTEN control, A and B gate circuits and external Z AXIS binding post. The output of this circuit is connected to the control grid of the CRT.

The CRT circuit produces the high voltage supply required to emit and accelerate the beam of the CRT.

The Power Supply circuit produces the low DC voltage supplies to operate each circuit of this instrument.

The Calibrator circuit produces a square-wave signal with accurate amplitude which can be used to check the deflection factor and compensation of the probes.

SECTION 5
MAINTENANCE

Warning

The following items must be cared when the maintenance work is made.

1. Dangerous potentials exist at several points throughout this instrument.

2. When the instrument is operated with the cover removed, do not touch exposed connections or compoments.

3. Some transistors may have elevated cases and heat sinks in the voltage.

4. Always disconnect the instrument from the power source beofre cleaning the instrument or replacing parts.

Cover Removal

The top and bottom covers can be removed by removing five and four mounting screws respectively.

PREVENTIVE MAINTENANCE

These are the precautions on preventive maintenance which will protect the instrument from trouble and keep it clean over a long period of time.

Cleaning

Since the extent of instrument smearing depends on the ambient condition in which the oscilloscope is used, the frequency of the cleaning operations cannot be defined initially. Cleaning should be accomplished as required. Dust deposited inside the instrument affects the normal flow of cooling air and invites the local overheating of component parts of results in trouble. Smeared switch contacts of connector pins can be the cause of defective contact, and smearing of the circuit can cause arcing between circuits, particularly in moist season.

Cleaning agents recommended and those prohibited are listed in Table 5-1.

Table 5-1

Recommended agent	Alcohol, gasoline of kerosene
Prohibited agent	Acetone, tri-ethyl-ketone, ether, lacquer thinner or agent containing ketone series solvent.

Cleaning the Cover

Normal smearing of the cover can be cleaned by washing the cover with a neutral chemical cleaner. For greasy smearing, use a recommended agent in Table 5-1 with a soft cloth.

Front and Other Panels

Clean the smeared panel with a soft cloth moistened with a recommended agent. Note that cleaning with alcohol may leave slight blotting. A neutral chemical cleaner may be used but the cleaner left on the panel or knob must be removed with a cloth soaked in water.

Dust in Instrument

The best way to remove dust inside the instrument is the blowing of compressed air. Remove persistent dust with a soft painting brush and blow the air again.

CRT

The CRT screen will be smeared if it is used for too long

without the filter. Ordinary dust of fingerprint left on the CRT can be cleaned by a soft cloth. Use a soft cloth moisted with alcohol to remove persistent smearing.

Filter

The filter may be clogged when used for a long time. Dust or fingerprint can be cleaned with a dry, soft cloth. Use a soft cloth moisted with alcohol to remove persistent smearing.

Before Preserving the Osilloscope

Before preserving the oscilloscope, remove the probe and adapter from the panel, and store these accessories in the accessory bag provided. Cover the oscilloscope, and store it in a dry place. It prevents deposition of dust.

Visual Inspection

Periodically inspect the condition of the internal circuit. Burnt resistor, defective contact of connection, broken printed circuit board and many other defects can be checked easily. Prompt repair of these minor defects can prevent troubles, or limit the defect within minor level.

Periodical Calibration

In order to use the oscilloscope accurately, periodical calibration of circuits is essential. When this oscilloscope is used frequently, a calibration will be required at every 1000 hours of operation. The frequency of calibration may be extended to 6 months, if the oscilloscope is used infrequently.

TROUBLESHOOTING

Troubleshooting Reference

Schematic Diagrams

In this manual, schematic diagrams are grouped, in general, with the circuit blocks classified in Fig. 4-1.

Circuit Layout

Layout of circuits on the printed circuit boards is shown in Figs. 5-1 to 5-2. Use the photographs for inspection.

Parts Layout

Refer to part No. printed on the printed circuit board to identify parts mounted on the board.

Color Code of Resistors and Capacitors

Most of the resistors and capacitors in the circuit are color coded by resistance or capacitance value. See Fig. 5-3 for the color code.

Electrodes Marking of Diodes and Transistors

Tables 5-2 and 5-3 show the electrodes marking of diodes and transistors, by type.

Instruments Required for Troubleshooting

The following instruments are required at least for troubleshooting of this oscilloscope.

1. Multimeter
   - Input resistance : 10 MΩ
   - Voltage range : 0 to 100V and special position for 2 kV
   - Ohm-range : 0 to 10 MΩ
2. Transistor curve tracer
3. Oscilloscope
   - Frequency bandwidth: DC to 20 MHz
   - Sensitivity : 5 mV/div

Fig. 5-1 Circuit layout (top)

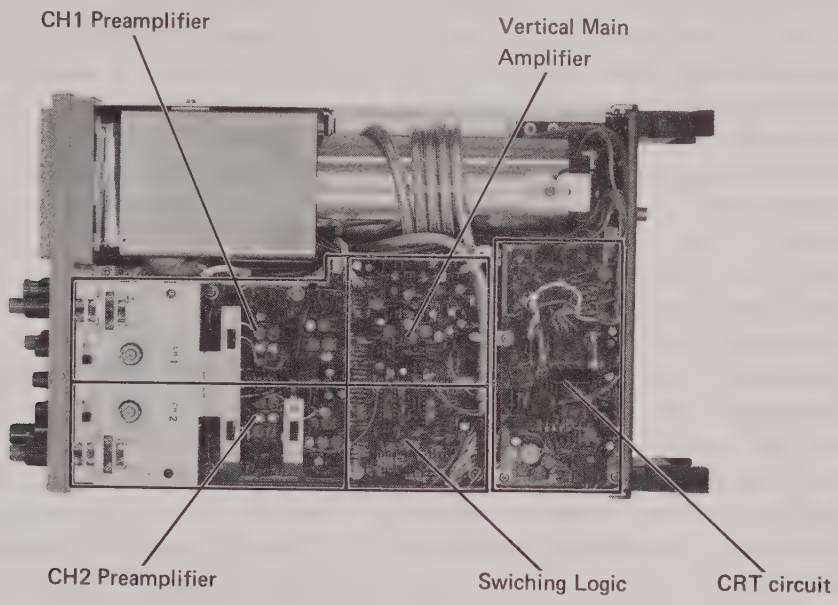
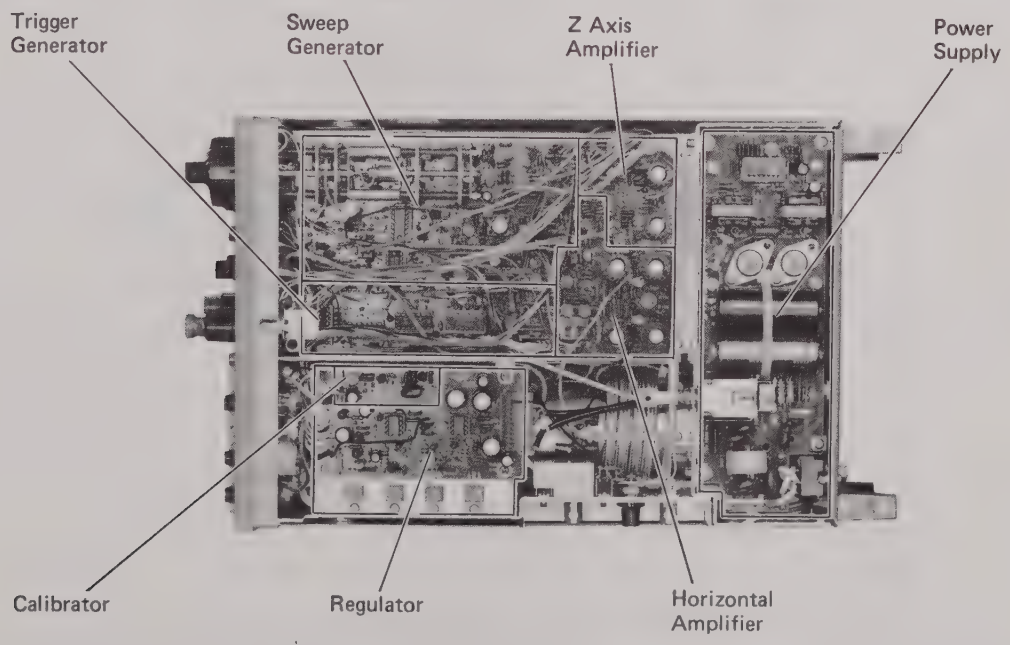


Fig. 5-2 Circuit layout (bottom)



Troubleshooting Steps

The first thing in troubleshooting is to examine if a irregular event like "a circuit trouble" is really due to a troubles within the circuit, or caused by external events. For example, certain irregular operations will occur, in a normal oscilloscope, if the line voltage is out of the rated voltage range, or an signal input connector is affected by induction of an external signal.

Then, repeatability of the trouble must be checked. For example, when sweep is normal but an irregular signal is displayed with a signal supplied to the signal input connector, the other signal must be supplied to the input to check if the same irregular display occurs (if it occurs, the oscilloscope is responsible for the trouble).

When troubles perist against these preparatory checks, the following actual steps must be performed.

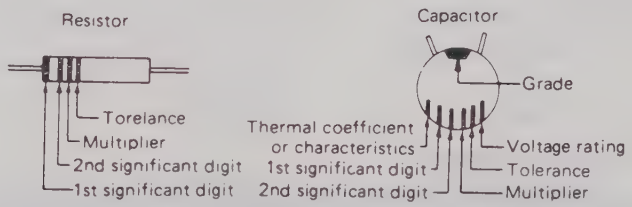
1. Remove the covers from the instrument and ascertain the circuit which has the trouble by the troubleshooting flow chart shown in Fig. 5-4.
2. Visually inspect parts, wirings, coupling of connectors, soldering and copper foils of the circuit board, which are suspect.
3. Check the action of the ascertained circuit by using a multimeter or test oscilloscope and refering the voltages and waveforms shown in the schematic diagram.
4. Finally, check suspect parts for the trouble by using a multimeter or curve tracer and replace the defective parts.

COMPONENT REPLACEMENT

In this paragraph, the replacement procedures of the defective components are described.

When the replacement of the components is required, be sure to disconnect the instrument from the power source.

Fig. 5-3 Color coading of resistor and capacitor



Color	Resistance or capacitance value		Tolerance for resistor	Tolerance for capacitor		Voltage rating for capacitor
	1st or 2nd significant digit	Multiplier		Above 10pF	Below 10pF	
BLK	0	1	–	±20.0	±2.0	–
BRN	1	10	±1	±1.0	–	–
RED	2	10^2	±2	±2.0	–	250V
ORG	3	10^3	–	±2.5	–	300V
YEL	4	10^4	–	–	–	–
GRN	5	10^5	–	±5.0	±0.5	500V
BLU	6	10^6	–	$\pm^{10}_{0}$	–	–
VLT	7	10^7	–	–	–	–
GRY	8	10^8	–	±10.0	±0.25	–
WHT	9	10^9	–	–	±1.0	1000V
GOLD	–	10^{-1}	±5	–	–	–
SILVER	–	10^{-2}	±10	–	–	–
No color	–	–	±20	–	–	–

Fig. 5-4 Troubleshooting flow chart

First, set the switches and controls as follows;

Front Panel

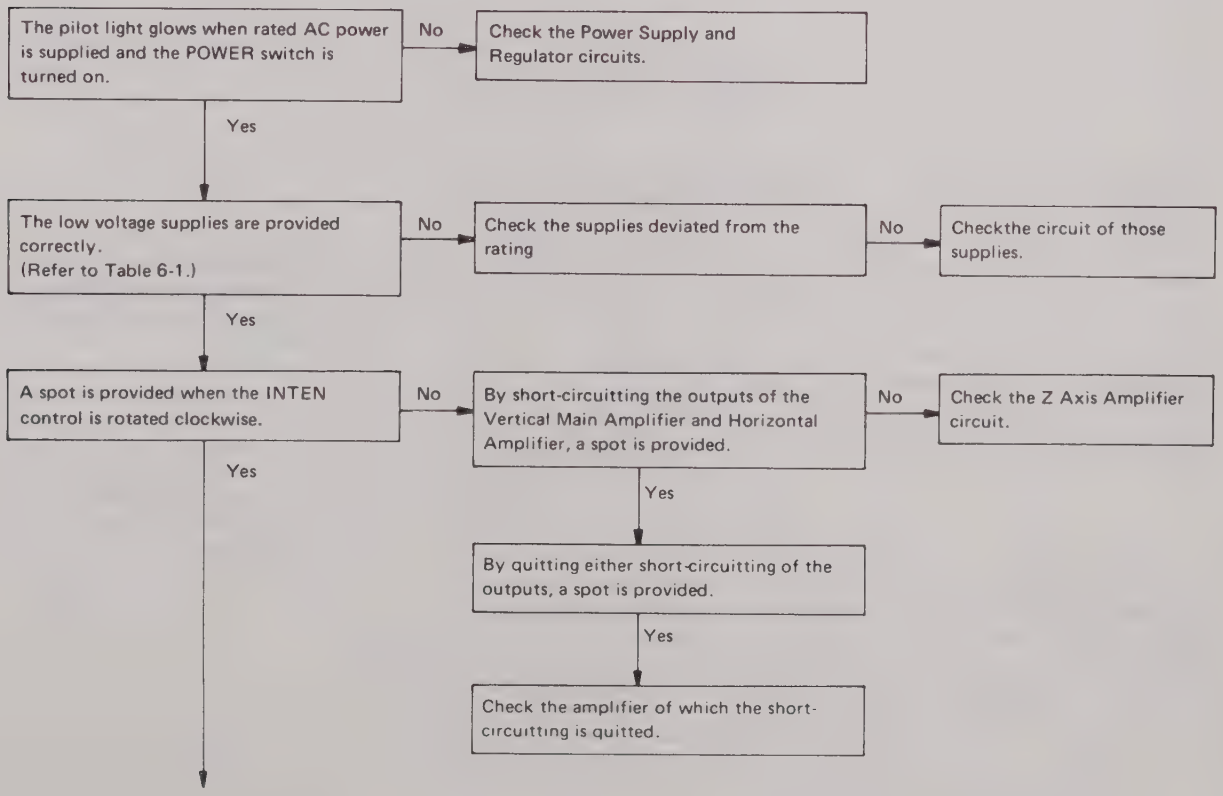
POWER	OFF
INTEN	Mid-range
FOCUS	Mid-range
DELAY	Fully counterclockwise
MODE (vertical)	CH1
VOLTS/DIV (CH1, CH2)	10 mV
VARIABLE (CH1, CH2)	CALIB
Vertical Position (CH1, CH2)	Mid-range
SOURCE	CH1
COUPL	NORM
SLOPE	+
DISP	A
MODE (sweep)	AUTO
A TIME/DIV	1 mSEC
B TIME/DIV	0.1 mSEC
Horizontal Position	Mid-range
Horizontal Position Fine (PULL x10)	Push, mid-range
LEVEL	Mid-range
HOLDOFF	Fully counterclockwise

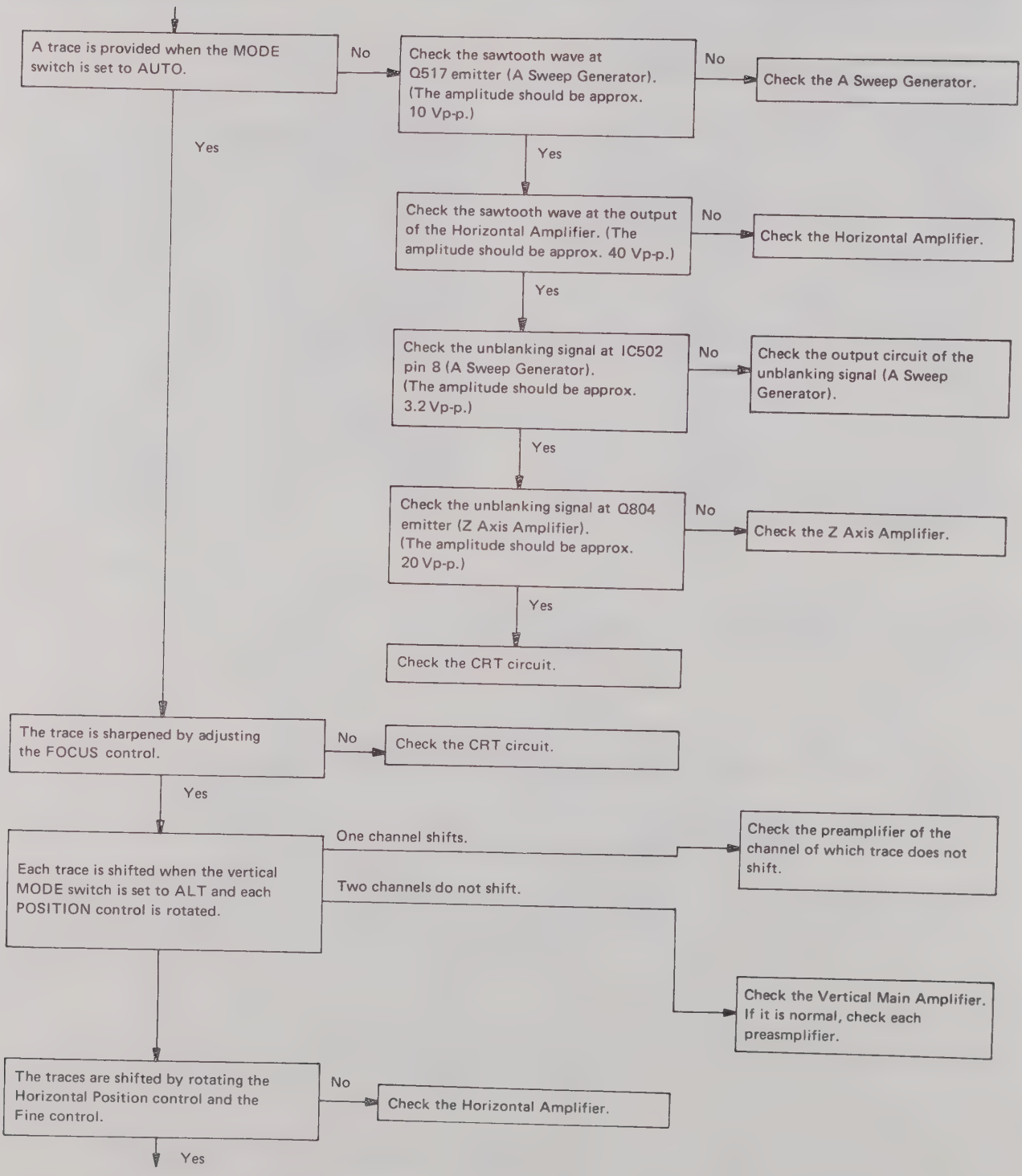
Top

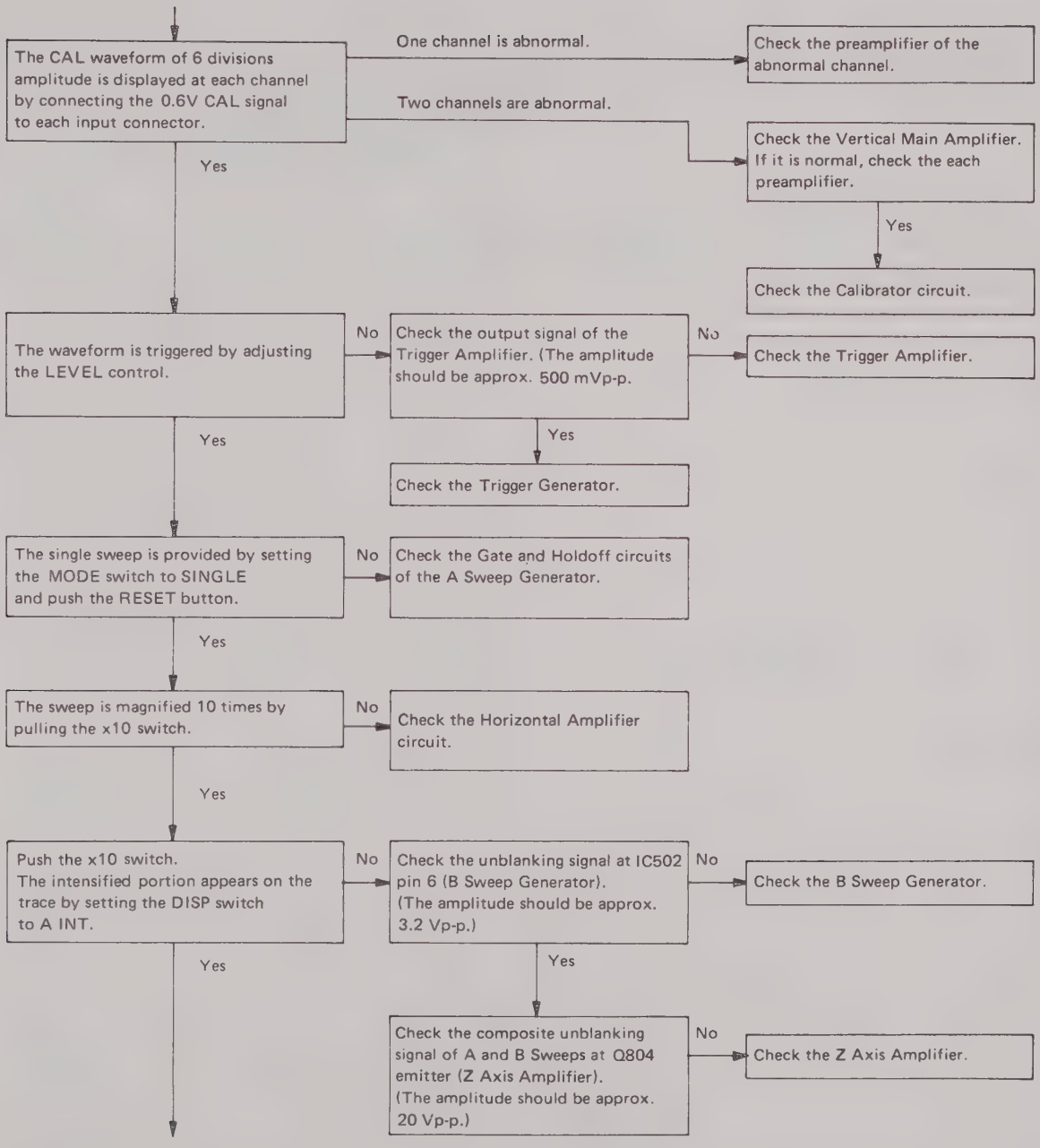
AC-GND-DC (CH1, CH2)	DC
GAIN (CH1, CH2)	X1
POLARITY	NORM

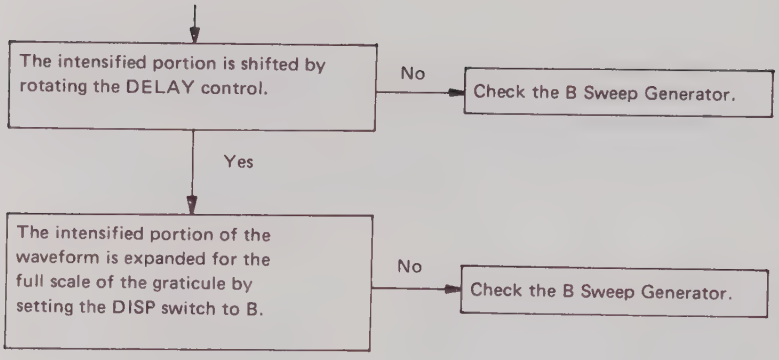
Left Side Panel

A VARIABLE	CALIB
B SWEEP	AUTO
AC-DC	AC


The pilot light glows when rated AC power is supplied and the POWER switch is turned on.
No
Check the Power Supply and Regulator circuits.
Yes
The low voltage supplies are provided correctly. (Refer to Table 6-1.)
No
Check the supplies deviated from the rating
No
Checkthe circuit of those supplies.
Yes
A spot is provided when the INTEN control is rotated clockwise.
No
By short-circuitting the outputs of the Vertical Main Amplifier and Horizontal Amplifier, a spot is provided.
No
Check the Z Axis Amplifier circuit.
Yes
Yes
By quitting either short-circuitting of the outputs, a spot is provided.
Yes
Check the amplifier of which the short-circuitting is quitted.


A trace is provided when the MODE switch is set to AUTO.
No
Check the sawtooth wave at Q517 emitter (A Sweep Generator). (The amplitude should be approx. 10 Vp-p.)
No
Check the A Sweep Generator.
Yes
Yes
Check the sawtooth wave at the output of the Horizontal Amplifier. (The amplitude should be approx. 40 Vp-p.)
No
Check the Horizontal Amplifier.
Yes
Check the unblanking signal at IC502 pin 8 (A Sweep Generator). (The amplitude should be approx. 3.2 Vp-p.)
No
Check the output circuit of the unblanking signal (A Sweep Generator).
Yes
Check the unblanking signal at Q804 emitter (Z Axis Amplifier). (The amplitude should be approx. 20 Vp-p.)
No
Check the Z Axis Amplifier.
Yes
Check the CRT circuit.
The trace is sharpened by adjusting the FOCUS control.
No
Check the CRT circuit.
Yes
Each trace is shifted when the vertical MODE switch is set to ALT and each POSITION control is rotated.
One channel shifts.
Check the preamplifier of the channel of which trace does not shift.
Two channels do not shift.
Check the Vertical Main Amplifier. If it is normal, check each preasmplifier.
The traces are shifted by rotating the Horizontal Position control and the Fine control.
No
Check the Horizontal Amplifier.
Yes


The CAL waveform of 6 divisions amplitude is displayed at each channel by connecting the 0.6V CAL signal to each input connector.
One channel is abnormal.
Check the preamplifier of the abnormal channel.
Two channels are abnormal.
Check the Vertical Main Amplifier. If it is normal, check the each preamplifier.
Yes
Yes
Check the Calibrator circuit.
The waveform is triggered by adjusting the LEVEL control.
No
Check the output signal of the Trigger Amplifier. (The amplitude should be approx. 500 mVp-p.
No
Check the Trigger Amplifier.
Yes
Yes
Check the Trigger Generator.
The single sweep is provided by setting the MODE switch to SINGLE and push the RESET button.
No
Check the Gate and Holdoff circuits of the A Sweep Generator.
Yes
The sweep is magnified 10 times by pulling the x10 switch.
No
Check the Horizontal Amplifier circuit.
Yes
Push the x10 switch. The intensified portion appears on the trace by setting the DISP switch to A INT.
No
Check the unblanking signal at IC502 pin 6 (B Sweep Generator). (The amplitude should be approx. 3.2 Vp-p.)
No
Check the B Sweep Generator.
Yes
Yes
Check the composite unblanking signal of A and B Sweeps at Q804 emitter (Z Axis Amplifier). (The amplitude should be approx. 20 Vp-p.)
No
Check the Z Axis Amplifier.


The intensified portion is shifted by rotating the DELAY control.
No
Check the B Sweep Generator.
Yes
The intensified portion of the waveform is expanded for the full scale of the graticule by setting the DISP switch to B.
No
Check the B Sweep Generator.

Circuit Board Removal

Vertical Board (PB0101—P-K1276C)

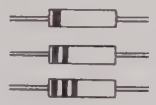
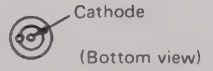
1. Disconnect six connectors on the Vertical board and one connector for wire connection between the Vertical and Horizontal boards on the Horizontal board.
2. Desolder five wires of the delay cable on the Vertical board.
3. Disconnect two CRT deflection pins.
4. Remove the attenuator shielding case by removing eight mounting screws.
5. Remove six mounting screws for the Vertical board.

Note: For disconnecting of the connectors of the SS-3510, push the knob of the connectors.

CRT Circuit Board (PB0901—P-K1279C)

1. Disconnect five connectors on the CRT circuit board.
2. Remove the CRT hold fitting by removing one mounting screw and disconnect the CRT socket.
3. Disconnect the CRT anode cap referring the removal manner of the CRT.
4. Removal four mounting screws for the CRT circuit board.

Table 5-2 Marking for diode electrode

Type of diode	Electrode marking	Polarity
1S953, 1S1544A 1S1835, 1N34A ESJA35-12		
1S1658		
RD3.9EB, RD5.1EB RD5.6EB, RD6.2EB		
TLG102KW TLR102KW TLY102KW		
2SB20DM		

Horizontal Board (PB0401—K-K1278C)

1. Draw out the front frame.
2. Disconnect nine connectors on the Horizontal board and one connector for wire connection between the Horizontal and Vertical boards on the Vertical board.
3. Disconnect two CRT deflection pins.
4. Desolder one wire between the A VARIABLE control and the A UNCALIB indicator at the terminal of the control.
5. Desolder one wire between the EXT TRIG IN connector and the COUPL switch at the terminal of the switch.
6. Remove four mounting screws for the Horizontal board. (See Figs. 5-5 and 5-6.)

Power Regulator Board (PB1001—P-K1280C)

1. Disconnect three connectors on the Power Regulator board.
2. Disconnect three connectors for wire connection between the Power Regulator and Horizontal boards on the Horizontal board.
3. Disconnect one connectors for wire connection between the Power Regulator and Vertical boards on the Vertical board.
4. Desolder six wires to the INTEN and DELAY controls.
5. Remove three mounting screws on the board and four mounting screws for power transistors. When removing the power transistor, refer to the replacement manner of the power transistor.

Power Supply Board (PB1101—K-K1282C, PB1102—P-K1281C)

1. Remove the coupling for extension rod of the POWER switch using a 3 mm hexagonal wrench (option).
2. Disconnect two connectors on the CRT Circuit and Power Regulator boards.
3. Desolder three wires from the power inlet.
4. Remove four mounting screws for the Power Supply board.

Attenuator Unit

1. Remove four knobs of the VOLTS/DIV switches and the VARIABLE controls.
2. Loose two nuts of the VOLTS/DIV switch.
3. Remove the attenuator shield case by removing eight mounting screws.
4. Pull out the earth plate spring mounted to chassis of the left side of the attenuator unit.
5. Remove one mounting screw on the center position of the attenuator circuit board.
6. Disconnect two connector on the vertical board.
7. Pull out the unit backwards.

Fuse Replacement

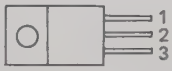
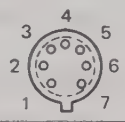
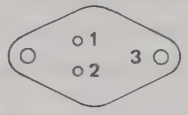
This instrument uses the fuses shown in Table 5-4 in order to prevent damage to the circuit due to overcurrent.

If these fuses are blown, check its cause correctly, repair the defective parts or circuits, and exchange the blown fuse with the prescribed new ones. The use of a new fuse which is not prescribed may result in danger; therefore, such use is prohibited.

Table 5-4

Circuit No.	Type of Fuses	Function	Location
F1101	1.5A Slow-blow	Protection of primary circuit	Power supply board
F1102	0.5A Rapid-blow	Protection of secondary circuit	
F701	1A Slow-blow	Protection of CRT circuit	CRT circuit board

Table 5-3 Marking for transitor electrode (bottom view)

Type of transistor	Electrode marking	Type of transistor	Electrode marking
2SA1015Y 2SC1815GR 2SC1834	1. Emitter 2. Collector 3. Base	2SB566C 2SC1507 2SC1061C 2SD288K	 1. Base 2. Collector 3. Emitter
2SC154C 2SC1199	1. Emitter 2. Base 3. Collector (case)		
2SC2037 2N3905 2N5771	1. Emitter 2. Base 3. Collector		
2N5912	 1. Source 5. Source 2. Drain 6. Drain 3. Gate 7. Gate 4. Case		
2SK19Y	1. Drain 2. Source 3. Gate		
2SC1865	 1. Base 2. Emitter 3. Collector (case)		

Parts on Printed Circuit Board

When replacing transistors, ICs, diodes, resistors or capacitors mounted on the printed circuit board, particular care must be exercised on the handling of the soldering iron so as not to peel the copper foil off or break parts.

The semiconductors are delicate to heat. When desoldering or soldering, hold the semiconductor side of the wire lead being heated with pliers or tweezers to absorb the soldering heat. Complete soldering or desoldering quickly.

The semiconductors must be replaced with qualified ones. Some of transistors and diodes are specially selected to ensure the performance of this instrument. Refer to Tables 5-2and 5-3 for identification of electrodes.

ICs are mounted with a socket or no socket (directly mounted). Pins of ordinary ICs are numbered as shown in Fig. 5-7 when the slot is positioned leftward. In special ICs made by IWATSU, pin No. 1 of B type is positioned at the white dot. IWATSU ICs are not interchangeable with other make because of special designs. In case of directly mounted ICs, a dot or 1 of number with white

Fig. 5-5 Mounting screws for horizontal board and CRT shield case

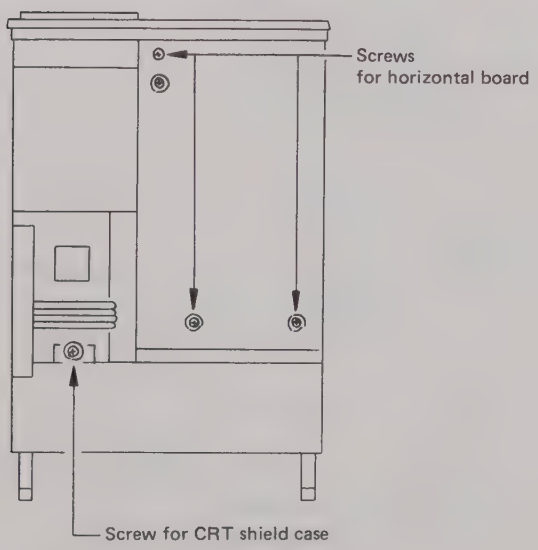


Fig. 5-6 Mounting screw for horizontal board

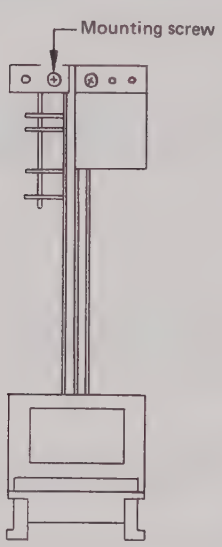
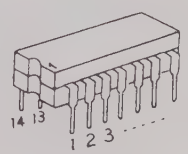
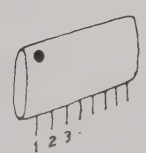


Fig. 5-7 Pin No. of IC



Ordinary IC module



IC made by IWATSU (B type)

color is marked to the position on the printed circuit board to which pin 1 of IC is to be set.

Resistors, capacitors and other passive parts must be also replaced with new ones. Burning out of resistors or short circuitting of capacitors can occur incidentally with short-circuitting of semiconductors or excessive variations in the characteristics. Therefore, check and remove the cause of these defects before replacing the passive parts.

CRT

Dropping of or excessive shock to the CRT is very hazardous. Handle the CRT with special care.

Replace the CRT, when required, in the sequence given below;

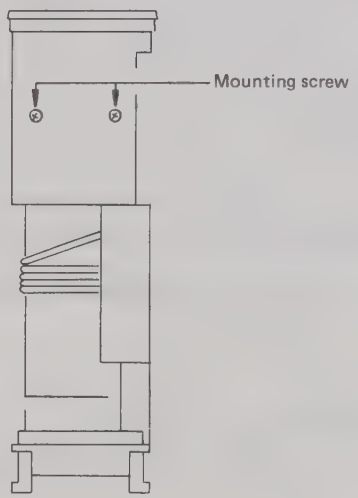
1. Remove the top cover.
2. Remove the CRT hold fitting by removing one mounting screw.
3. Disconnect the CRT socket.
4. Disconnect one connector for wire connection of the rotation coil on the CRT circuit board.
5. Disconnect four wire connection to the CRT deflection pins.
6. Remove three mounting screws for the CRT shield case. (See Figs. 5-5 and 5-8.)
7. Pull up the CRT togather with the shield case.
8. Disconnect the CRT anode cap. When disconnecting the anode cap, it should be grounded for discharging purpose since it may be charged by the high voltage.
9. Pull out the CRT from the shield case.

The CRT can be mounted in the reversed manner. When the CRT is replaced, vertical deflection factor and sweep rate must be calibrated.

Power Transistor

The power transistors in the CRT and power regulator circuits are mounted on the rear panel and the left side chassis respectively with a insulation mylar film sheet inserted between the transistor and the sub-panel. The mylar sheet is coated with the silicon grease to improve the thermal condition. In case of replacement of these transistors, the mylar sheet coated with the silicon grease must be correctly inserted.

Fig. 5-8 Mounting screws for CRT shield case



SECTION 6
PERFORMANCE CHECK AND CALIBRATION

Period of Check and Calibration

Since the performance of this instrument is subjected to aging variation, periodical check and calibration of the device is required.

If the instrument is used frequently, a check and calibration will be required after each 1000 hours, but the interval after the last check and calibration may be prolonged to 6 months, if it not used so frequently.

Instrument Required for Check and Calibration

The following measuring instruments and accessories are required in order to provide a performance check and calibration for this instrument.

1. Digital voltmeter
   - Voltage range: 0 to 100V DC (direct)
     Accuracy: ±0.05% + 1 dgt
     0 to 2 kV DC (with high-voltage probe)
     Accuracy: ±5% + 1 dgt
     Example: IWATSU VOAC727
2. Scope calibrator — Example: IWATSU SC-340
3. Sine wave generator
   - Frequency range: 1 to 50 kHz
   - Output voltage: 80 mVp-p or more
     Example: IWATSU FG-330
4. Standard signal generator
   - Frequency range: 50 kHz to 50 MHz
   - Output voltage: 60 mVp-p or more
5. Voltage regulator
6. Passive probe — Accessory
7. BNC-T connector
8. Non-inductive screwdriver
   Example: Probe adjustment screwdriver, an accessory

Notes:

1. The performance requirements shown above are the minimum requirements for testing the instruments connected.
2. Signal input connector of this instrument is the BNC type. If the output connector of a terminator or another test instrument is not BNC type, a conversion connector must be prepared to connect the instrument directly to this oscilloscope.

Table for Check and Calibration Items

In this paragraph, the check and calibration items are enumerated to show the interaction between the items. When the item which has interaction for other items is calibrated, those items must also be calibrated. Besides, the check and calibration of the vertical deflection system must be made in numerical order.

—Power Supply, CRT Circuit and Calibrator—

1. Low Voltage Power Supply
   (Interaction: All items)
2. Operating Voltage Range
3. CRT Cathode Voltage
   (Interaction: 13, 28, 29, 32)
4. Intensity
5. Parallelness of Vertical and Horizontal Traces to Graticule Line
6. Pattern Distortion
7. Focus
8. Output Voltage of Calibrator

—Vertical Deflection System—

9. Deflection Factor
10. Gain Balance
11. Variable Balance
12. Polarity Balance
13. Channel 2 Position Range
14. Main Amplifier Balance

15. Volts/Div Compensation
16. Pulse Response
    (Interaction: 17)
17. Frequency Response
18. Noise
19. Linearity

—Triggering and Horizontal Deflection System—

20. Level Centering
21. Sweep Length
22. Sweep Rate
23. B Sweep Start Point
24. Sweep Rate at Magnified Sweep
25. Magnifier Centering
26. Delay Jitter
27. Delay Time

—X-Y Operation—

28. Deflection Factor
    (Interaction: 29)
29. Spot Position
30. Phase Difference

Precautions

The following precautions must be observed before checking and calibrating the performance of this instrument.

1. It is assumed, in this section, that the setting of controls is made in the position described in the section concerning "Preparation". Therefore, the controls must be set to the positions given in "Preparation", prior to starting check and calibration of items or limited to partial ones.
2. Signal outputs of signal generators must be terminated with the rated output impedance (terminator).
3. Since the low power supply voltages are commonly supplied to all circuits, excessive increase in the ripplies and voltage error will affect the performance of the circuits. Be sure to check the power supplies before starting the check and calibration of the circuit performance.
4. If a circuit does not operate as described, or it does not satisfy the rated performance, troubleshooting is required as given in section of Maintenance. Repeat calibration of the circuit, after repaired.

Preparation

Be sure to complete the preparation given below before starting the check and calibration.

1. Adjust the ambient temperature within 10°C to 35°C.
2. Set controls as given below before supplying the power to the instrument.

—Front panel—	
POWER	OFF
INTEN	Mid-range
FOCUS	Mid-range
MODE(vertical)	ALT
VOLTS/DIV (CH1, CH2)	10mV
VARIABLE (CH1, CH2)	CALIB
Vertical Position (CH1, CH2)	Mid-range
SOURCE	CH1
COUPL	NORM
SLOPE	+
DISP	A
MODE (sweep)	AUTO
A TIME/DIV	1 mSEC
B TIME/DIV	0.1 mSEC
LEVEL	Mid-range
HOLDOFF	MIN
Horizontal Position	Mid-range
Fine (PULL x 10)	Push, Mid-range
DELAY	Fully counterclockwise
—Top—	
AC-GND-DC (CH1, CH2)	DC
GAIN (CH1, CH2)	X1
POLARITY	NORM

—Left Side Panel—

A VARIABLE	CALIB
B SWEEP	AUTO

3. Turn on the POWER switch, adjust the intensity of the traces, and allow the instrument to warm up for about 30 minutes.
4. Set the vertical MODE switch to CH1.

—Power Supply, CRT Circuit and Calibrator—

Low Voltage Power Supply

Rating

Output DC voltages must be within the range shown in Table 6-1.

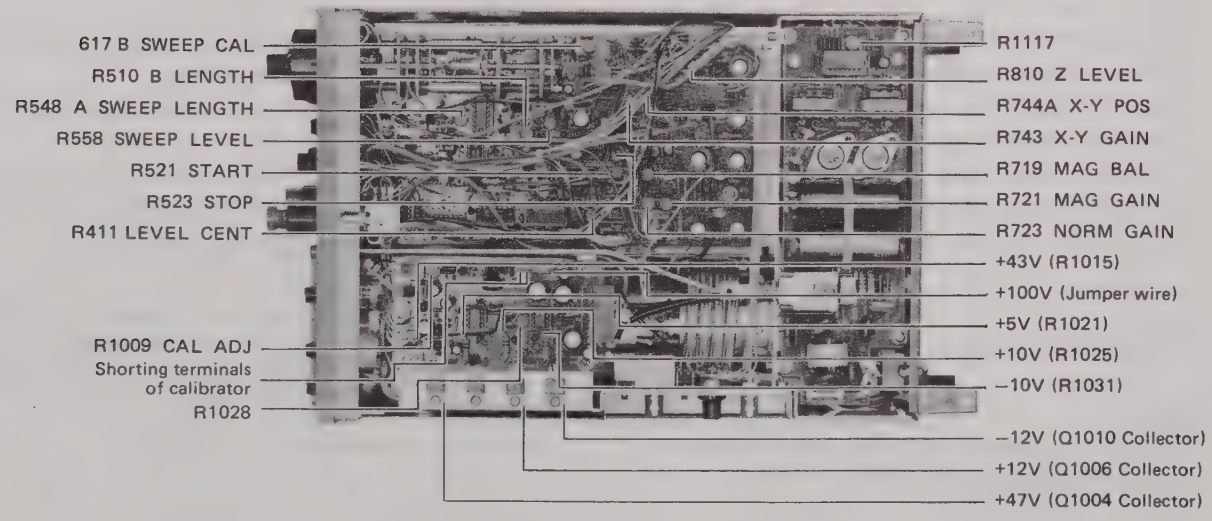
Table 6-1

	Nominal voltage	Output voltage accuracy	Calibration control
Collector side (input) of series regulator	+12V	±0.5%	R1117
	−12V	±2.0%	—
	+47V	±5.0%	—
Emitter side (output) series regulator	+10V	±0.5%	R1028
	+ 5V	±2.0%	—
	−10V	±2.0%	—
	+43V	±3.0%	—
	+100V	±10.0%	—

Check and Calibration

1. Connect a digital voltmeter between each test point shown in Fig. 6-1 and the ground terminal on the rear panel, and check if the output voltages are within the rating given in Table 6-1.

Fig. 6-1 Test points and calibration controls (bottom)



2. If the supply voltages are out of the rating, calibrate +12V and +10V supplies by R1117 and R1028 (see Fig. 6-1) respectively, and check other supplies. The Power Supply circuit is designed so that other supply voltages are in the rated range by no calibration when +12V and +10V supplies are calibrated.

Operating Voltage Range

Rating

The display must be sufficiently stable against variation in the voltage range given in Table 6-2.

Table 6-2

100V – 200V switch	Voltage range
100V	85 to 130V
200V	170 to 260V

Check

1. Turn off the POWER switch and disconnect the power cord from the line receptacle. Connect the power cord to the line through a voltage regulator (slide auto transformer), and set the regulator output voltage to the rated center voltage
2. Turn on the POWER switch and connect the CAL 0.3V signal to the input connector using the accessory probe. The signal amplitude should be 6 divisions.
3. Set the A TIME/DIV switch to 10m SEC.
4. Vary the regulator output voltage continuously within the rated voltage range. Neither ripple nor intensity modulation must appear in the display.

CRT Cathode Voltage

Rating

The CRT cathode voltage with respect to the ground must be within −1400V +0V, −10V.

Note:

If the CRT cathode voltage is not exactly −1400V, but within the rating +0V to −10V, calibration of this voltage is not required excepting the following cases.

1. Overall calibration of all items.
2. Calibration of the deflection factor and the sweep rate.

Check and Calibration

1. Check that the CRT cathode voltage is within rating, by connecting a digital voltmeter (with a high voltage probe) between the test point of the CRT cathode (see Fig. 6-2) and chassis.
2. If the voltage is out of the rating, adjust R908 HV ADJ (see Fig. 6-2).

Intensity

Rating

A spot must appear when the INTEN control is rotated fully clockwise, and the trace must disappear when the control is rotated fully counterclockwise.

Check and Calibration

1. Set the sweep MODE switch to SINGLE to stop the sweep
2. Rotate the INTEN control fully clockwise and check that a spot is visible on the CRT.
3. Start the sweep by setting the sweep MODE switch to AUTO.
4. Rotate the INTEN control fully counterclockwise and check that the trace disappears.
5. If above checks reveal unsatisfactory result, adjust as follows.
6. Set the MODE switch and the INTEN control to NORM and fully clockwise position respectively, and adjust R915 INT ADJ (see Fig. 6-2) so that a spot is visible on the CRT
7. Set the MODE switch and the INTEN control to AUTO and fully counterclockwise position respectively, and adjust R810 Z LEVEL (see Fig. 6-1) so that the trace disappears.
8. Repeat the adjustments in items 6 and 7.

Trace Rotation

Notes:

As the parallelness of the traces to a scale line is somewhat affected by the ground magnetism, check and cali-

brate the instrument in the actually used position.

Check and Calibration

1. Set the CH1 AC-GND-DC switch to GND.
2. Adjust the CH1 POSITION control to see the trace on the center horizontal line of the graticule and check the parallelness of trace to the line.
3. If the trace is not exactly, parallel to the center horizontal line, adjust R928 ROTATION (see Fig. 6-2).

Pattern Distortion

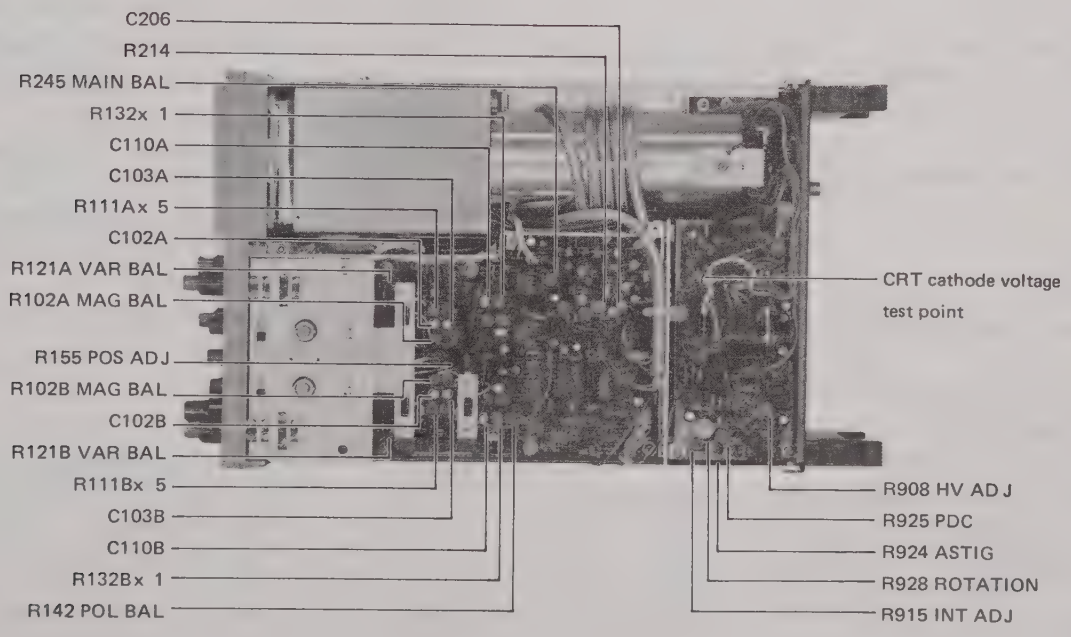
Rating

When a raster is fully displayed in the 8 division (V) by 10 division (H) area, the sides of the raster must be straight not exceeding the limit 0.32 division (vertical) and 0.26 division (horizontal) as shown in Fig. 6-3.

Check and Calibration

1. Connect the signal of a sine wave generator to the CH1 INPUT connector.
2. Adjust the signal output level to set the display amplitude to 8 divisions.
3. Set the signal frequency to approximately 20 kHz and the A TIME/DIV switch to 1 mSEC so that a raster may be displayed.
4. Check the curvature of the upper and lower ends of the raster from the horizontal scale.
5. Adjust the horizontal POSITION control to set the vertical ends of the raster with the left or the right ends of the vertical scale, and check the curvature of the raster from the scale line.
6. If the curvature of the raster from the scale lines exceeds

Fig. 6-2 Calibration controls (top)



the rating, adjust R925 PDC (see Fig. 6-2) to make the pattern distortion to minimum.

Focus

Check and Calibration

1. Connect the OUTPUT 2 signal of the scope calibrator, SC-340 to the CH1 INPUT connector.
2. Push the left button of the SINE WAVE switch of the SC-340.
3. Set the display amplitude to 8 divisions.
4. Adjust the FOCUS control to obtain optimum definition of the display and check definition on whole of the display.
5. If the definition is poor, adjust R924 ASTIG (see Fig. 6-2).

Output Voltage of Calibrator

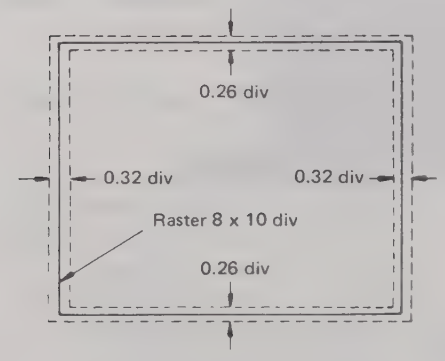
Rating

0.6V ± 1%

Check and Calibration

1. Turn off the POWER switch and short between shorting points of the Calibrator circuit (see Fig. 6-1) using a switable wire. This short grounds Q1001 base and stops oscillation of the Calibrator circuit.
2. Turn on the POWER switch.
3. Connect a digital voltmeter between the CAL 0.3V terminal and chassis and check if the displayed value of the voltmeter is within 0.594 to 0.606.
4. If it is out of rating, adjust R1009 CAL ADJ (see Fig. 6-1).

Fig. 6-3 Pattern distortion



—Vertical Deflection System—

Deflection Factor

Rating

x 1 gain:	±3%
x 5 gain:	±4%

Check and Calibration

1. Connect the OUTPUT 2 signal of the scope calibrator, SC-340 to the INPUT connector, and push the SQUARE WAVE 1 button of the SC-340.
2. Set the GAIN switch to x1, and check display amplitude when setting the VOLTS/DIV switch of the SS-3510 and the AMPLITUDE switch of the SC-340 as shown in Table 6-3.
3. If the accuracy is out of the rating, calibrate it with R132A(CH1)/R132B(CH2) x 1 (see Fig. 6-2).
4. Set the GAIN switch to x5, and check display amplitude when setting the VOLTS/DIV and AMPLITUDE switches as shown in Table 6-4.
5. If the accuracy is out of the rating, calibrate it with R111A(CH1)/R111B(CH2).

Table 6-3

VOLTS/DIV	AMPLITUDE	Display amplitude
10	60 mV	6
20 mV	120 mV	6
50	0.3 V	6
0.1	0.6	6
0.2	1.2	6 division ±3%
0.5	3	6
1 V	6 V	6
2	12	6
5	30	6

Table 6-4

VOLTS/DIV	AMPLITUDE	Display amplitude
10	12	6
20 mV	30 mV	7.5
50	60	6
0.1	120	6
0.2	0.3	7.5 division ±4%
0.5 V	0.6	6
1	1.2 V	6
2	3	7.5
5	6	6

Gain Balance

Check and Calibration

1. Set the vertical MODE switch to ALT.
2. Check if traces of CH1 and CH2 shift vertically when switching the GAIN switch.
3. If the traces shift, adjust R102A (CH1)/R102B (CH2) MAG BAL (see Fig. 2-2).

Variable Balance

Check and Calibration

1. Set the vertical MODE siwtch to ALT.
2. Check if each trace shifts vertically when rotating the VARIABLE controls of CH1 and CH2 through each range.
3. If the traces shift, adjust R121A (CH1)/R121B (CH2) VAR BAL (see Fig. 6-2).

Polarity Balance

Check and Calibration

1. Set the controls as follows.
   MODE (vertical) ALT
   AC-GND-DC (CH2) GND
   Vertical Position (CH2) Mid-range
2. Check if the CH2 trace shifts vertically when switching the POLARITY switch.
3. If the trace shifts, adjust R142 POL BAL (see Fig. 6-2).

CH2 Position Variable Range

Check and Calibration

1. After calibrating the Polarity Balance and the Main Amplifier Balance, check distance between the CH2 trace and center horizontal line of the graticule when setting the CH2 Position control to mid-range.
2. If the distance is large, adjust R115 POS ADJ (see Fig. 6-2).

Main Amplifier Balance

Check and Calibration

1. After calibrating the Polarity Balance, adjust the CH2 Vertical Position control to obtain CH2 trace position which does not shift even if the POLARITY switch is switched.
2. Check distance between the CH2 trace and center horizontal line of the graticule.
3. If the distance is large, adjust R254 MAIN BAL (see Fig. 6-2).

Volts/div Compensation

Rating

Overshoot or rounding: ±3%
Flatness: ±3%

Check

1. Connect the accessory probe between the INPUT connector and the OUTPUT 2 connector of the SC-340.
2. Set the A TIME/DIV switch to 0.5 mSEC.
3. Push the SQUARE WAVE 1 button and set the AMPLITUDE switch of the SC-340 to 0.6V.
4. As the above operation allows 6 division amplitude of the signal on the screen, adjust the probe compensation variable capacitor for optimum pulse flat top (see Fig. 6-6).
5. Set the VOLTS/DIV switch and the AMPLITUDE switch to 20mV and 1.2V respectively to obtain 6 division display, and check if overshoot or rounding on the leading edge and pulse flat top are within rating.

6. Similarly check compensation in each range of the VOLTS/DIV switch by switching the VOLTS/DIV and AMPLITUDE switches in regular sequence.

Calibration

Adjust the calibration controls shown in Table 6-5 and Fig. 6-7.

Table 6-5

VOLTS/DIV	Calibration control	
	Overshoot or rounding	Flatness
10 mV	–	C002A/B
20 mV	C014A/B	C015A/B
50 mV	C016A/B	C017A/B
0.1 V	C008A/B	C009A/B
0.2 V	–	–
0.5 V	–	–
1 V	C011A/B	C012A/B
2 V	–	–
5 V	–	–

Notes:

1. In range of ——, no adjustment is required. The calibration is completed spontaneously through the adjustment of the others.
2. C002A/B are variable capacitor to adjust the input capacitance within the rating and to determine the adjusted point of the probe compensation variable capacitor. Therefore, do not rotate C002A/B in case other than above-mentioned adjustment.

Pulse Response

Rating

Overshoot: 6%
Sag (1 kHz): 2%
Other distortion: 5%
(At 10mV/div, x1 gain. Refer to Figs. 6-4 and 6-5.)

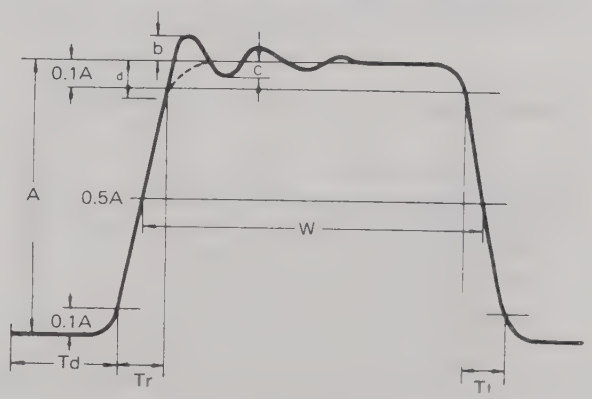
Check and Calibration

1. Connect the OUTPUT 3 signal of the SC-340 to the INPUT connector. Terminate the output correctly using a 50Ω terminator.
2. Set the controls of the SC-340 as follows:
   SQUARE WAVE 2 Push
   REPETITION 1 kHz
   ATTEN 20 dB
   AMPL Adjust to set the display amplitude to 4 divisions.
3. Set the A TIME/DIV switch so that several cycles of the square wave are displayed on the screen.
4. Position the display to the center on the screen and check the sag.
5. Set the REPETITION switch to 1 MHz. Set the A TIME/DIV switch and the A VARIABLE control so that about one cycle is displayed on the screen.
6. Check if overshoot or rounding on the leading edge and ringing are within the rating.
7. If the overshoot or rounding exceeds the rating, adjust the following calibration controls (see Fig. 6-2).
   For CH1: C102A, C103A, C110A
   For CH2: C102B, C103B, C110B
   Common to CH1 and CH2: R214, C206
   Note that these controls must be adjusted so that the rising edge of the waveform can rise as sharp as possible while minimizing overshoot, otherwise, frequency response will be affected.

Note:

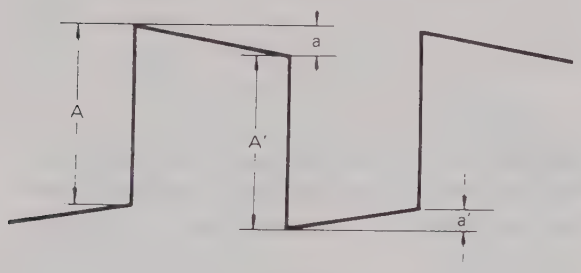
When the above adjustment is made, the frequency response must be checked with the procedure explained in the following item, Frequency Response.

Fig. 6-4 Definition of pulse terms
(By MEA-27, Japanese Electric Machinery Industry Association)



A : Basic amplitude
b/A : Overshoot
c/A : Ringing
W : Pulsewidth
T : Rise time
Tf : Fall time
d/A : Rounding
Td : Signal delay time

Fig. 6-5 Sag waveform (By MEA-27, Japanese Electric Machinery Industry Association)



A : Basic amplitude
a : Sag

Sag = a/A (or a'/A', whichever larger) x 100%

Frequency Response

Rating

DC to 50 MHz – 3 dB
(at 10 mV/div to 50 mV/div)

Check

1. Connect the output signal of a standard signal generator to the INPUT connector.
2. Set the signal frequency to 50 kHz and adjust the signal output level to set the display amplitude to 6 divisions.
3. Shift the display to the center 6 division area.
4. Set the signal frequency to 50 MHz and check if the amplitude is 4.25 divisions or more (–3 dB referred to 6 divisions).

Noise

Rating

x1 gain:	0.1 div p-p or less
x 5 gain:	0.2 div p-p or less

Check

1. Set the controls as follows.

MODE(vertical)	ALT
VOLTS/DIV (CH1, CH2)	10mV
GAIN (CH1, CH2)	x 1
AC-GND-DC (CH1, CH2)	GND

2. Adjust the INTEN control for desired brightness of trace and check that the thickness of the trace caused by noise is 0.1 div p-p or less.
3. Set the GAIN switch to x5 and check that the thickness is 0.5 div p-p or less.

Linearity

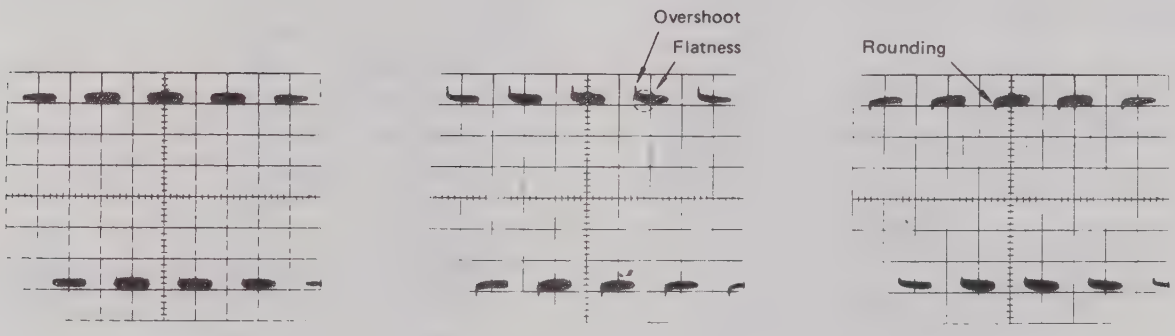
Rating

±5% (at 1 kHz)

Check

1. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector and push the SQUARE WAVE 1 button.
2. Rotate the VOLTS/DIV switch and the VARIABLE control to set the display amplitude to 2 divisions in the center 2 division area.
3. Shift the waveform to the upper/lower of the graticule area until the top/buttom of the waveform reaches the end of the graticule and check that the variation of the display amplitude is within 0.1 division.

Fig. 6-6 Attenuator compensation



Correct compensation | Over compensation | Poor compensation

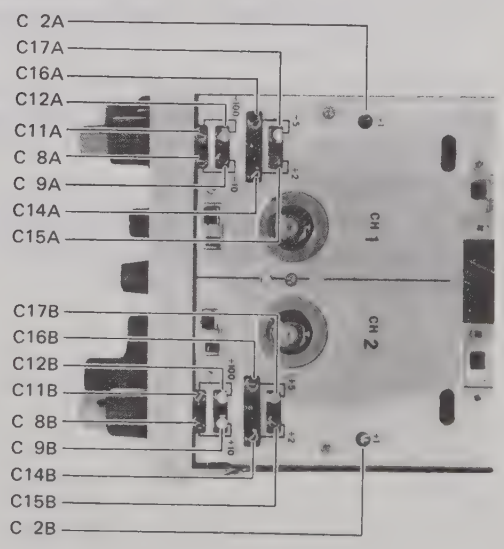
—Triggering and Horizontal Deflection System—

Level Centering

Check and Calibration

1. Connect the signal of a sine wave generator to the INPUT connector.
2. Set the signal frequency to 1 kHz and set the TIME/DIV switch to 2 mSEC.
3. Adjust the signal output level to obtain a 6 division display.
4. Rotate the Vertical Position control to set the display on the center 6 division area of the screen.
5. Allow triggering by setting the LEVEL control to the mid-range.
6. Check if the sweep start points are positioned on the center horizontal line of the graticule.
7. If the start points deviate from the center line, adjust R411 LEVEL CENT (see Fig. 6-1).

Fig. 6-7 Calibration controls for attenuator compensation



Sweep Length

Check and Calibration

1. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector.
2. Push the PULSE TRAIN left button and set the REPETITION switch to 1 mSEC.
3. Set the A TIME/DIV switch and the A VARIABLE control to 1 mSEC and CALIB respectively, and check if twelve marker pulses are displayed on the screen.
4. If the error is large, adjust R548 A SWEEP LENGTH (see Fig. 6-1).
5. Set the DISP and B TIME/DIV switches to B and 1 mSEC respectively, and check if twelve marker pulses are displayed on the screen.
6. If the error is large, adjust R510 B LENGTH (see Fig. 6-1).

Sweep Rate

Rating

Accuracy I
(over 8 divisions) ±3%
Accuracy II
(over any 2 divisions within 8 divisions):±5%

Check I [A Sweep Rate]

1. Set the controls as follows.

DISP	A
MODE	NORM
A TIME/DIV	1 mSEC
A VARIABLE	CALIB

2. Connect the OUTPUT 2 signal of the SC-340 to the CH1 INPUT connector.
3. Push the PULSE TRAIN left button and set the REPETITION switch to 1 mSEC.
4. Allow triggering and check accuracy I and II (see Fig. 6-8 and 6-9).
5. Check accuracy I and II for different combinations of the settings between the A TIME/DIV and REPETITION switches.

Check II [B sweep rate]

1. After the Check I, set the controls as follows;

DISP	B
B SWEEP (left side)	TRIG
A TIME/DIV	1 mSEC
B TIME/DIV	0.5 mSEC

2. Set the REPETITION switch to 0.5 mSEC and check accuracy I and II.
3. Check accuracy I and II for different combinations of the settings between the B TIME/DIV and REPETITION switches.

Calibration I [When both errors of A and B sweep rate have the same tendency]

Calibrate both erros with R723 NORM GAIN (see Fig. 6-1).

Calibration II [When errors in all ranges of B sweep rates have the same tendency]

Calibrate the errors of B sweep rate with R617 B SWEEP CAL (see Fig. 6-1).

Calibration III [When errors in particular ranges are large]

The errors in higher sweep rate ranges can be calibrated with variable capacitors shown in Table 6-6 and Fig. 6-1.

Table 6-6

Switch	Range	Variable capacitor
A TIME/DIV	0.1 μSEC to 0.5 μSEC	C614
	1 μSEC to 5 μSEC	C612
B TIME/DIV	0.1 μSEC to 0.5 μSEC	C621

Notes:

1. No variable capacitors are for accuracy II.
2. When R723 NORM GAIN is rotated, the sweep rate at magnified sweep must be calibrated with the procedure described in the following item.

B Sweep Start Point

Check and Calibration

1. Set the controls as follows.

DISP	A
MODE (sweep)	AUTO
Horizontal Position	

Fine (PULL x 10) Pull

2. Check if the B sweep start point deviates from the A sweep start point when setting the DISP switch to B.
3. If distance between the A and B sweeps is large, adjust R558 SWEEP LEVEL (see Fig. 6-1) so that the B sweep may start from the same point as the start point of the A sweep.

Sweep Rate at Magnified Sweep

Rating

Accuracy I

[over center 8 divisions] : ±4%

Accuracy II

[over any 2 divisions within center 8 division area] :

10 ns/div to 50 ns/div ±15%

0.1 μs/div to 20 ms/div ±5%

Note;

The above-mentioned accuracy is rated excepting 60 ns from the sweep start point and 60 ns from the sweep end point.

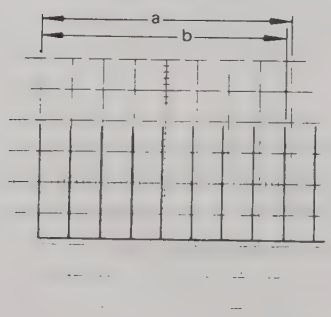
Check and Calibration

1. Set the controls as follows:

DISP	A
MODE	NORM
A TIME/DIV	0.1 mSEC
A VARIABLE	CALIB

2. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector.
3. Push the PULSE TRAIN left button and set the REPETITION switch to 0.1 mSEC.
4. Allow triggering and position the start pulse to the left end of the graticule.
5. Set the A TIME/DIV to 1 mSEC and pull the x10 switch, and check accuracy I and II (see Figs. 6-10 and 6-11).
6. If the accuracy I is poor, calibrate is R721 MAG GAIN (see Fig. 6-1).
7. Check accuracy I and II for different combinations of the settings between the A TIME/DIV and REPETITION switches.
8. If accuracy II from 10 ns/div to 50 ns/div is poor, calibrate it with C704 and C708 (see Fig. 6-1).

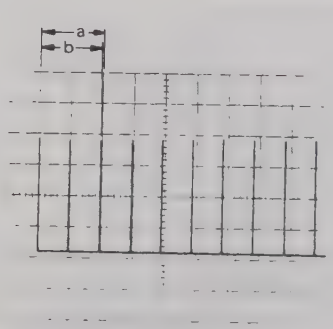
Fig. 6-8 Sweep rate error (I)



$$\text{Error rate} = \frac{a - b}{a} \times 100\ (\%)$$

where a : Horizontal effective scale (8 div)
b : Measured value of pulse train corresponding to a.

Fig. 6-9 Sweep rate error (II)



$$\text{Error rate} = \frac{a - b}{a} \times 100\ (\%)$$

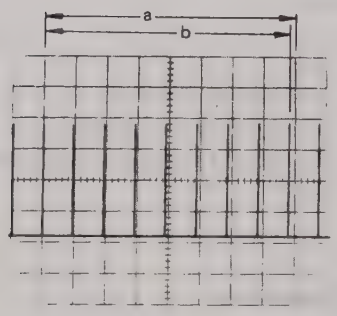
where a : Any 2 divisions of effective scale
b : Measured value of pulse train corresponding to a.

Magnifier Centering

Check and Calibration

1. Connect the CAL 0.6V signal to the INPUT connector with the accessory probe.
2. Set the A TIME/DIV switch to 1 mSEC.
3. Line the start point of the trace (rising edge of the signal) to the center vertical line of the graticule with the Horizontal Position control.
4. Pull the PULL x10 switch and check if the start point of the trace shifts.
5. If the start point shifts excessively, with the Horizontal Position control, set the start point of the magnified sweep correctly to the vertical center line. Next, push the PULL x10 switch and adjust R719 MAG BAL (see Fig. 6-1) so that the start point of the normal sweep is positioned to the center vertical line correctly.

Fig. 6-10 Sweep rate error at magnified sweep (I)



$$\text{Error rate} = \frac{a - b}{a} \times 100\ (\%)$$

where a : Horizontal effective scale (8 div)
b : Measured value of pulse train corresponding to a.

Delay Jitter

Rating

1/20,000 or less

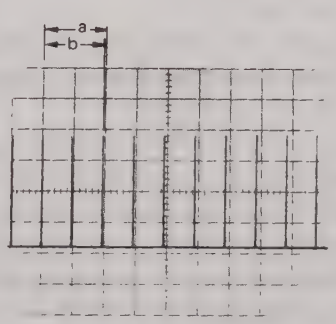
Check

1. Set the controls as follows:

DISP	A INT
B SWEEP	AUTO
A TIME/DIV	1 mSEC

2. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector.
3. Push the PULSE TRAIN left button and set the REPETITION switch to 1 mSEC.
4. Allow the SS-3510 for a stable triggering.
5. Set the DISP switch to B and the B TIME/DIV switch to 1 μSEC.

Fig. 6-11 Sweep rate error at magnified sweep (II)



$$\text{Error rate} = \frac{a - b}{a} \times 100\ (\%)$$

where a : Any 2 divisions of effective scale
b : Measured value of pulse train corresponding to a.

6. Display one of the pulse to the center of the CRT by rotating the DELAY control slighty counterclockwise from the fully clockwise position and check that the jitter is within 0.5 division.

Delay Time

Rating

±3%

Check and Calibration

1. Set the controls as follows;

DISP	A INT
B SWEEP	AUTO
A TIME/DIV	1 mSEC
B TIME/DIV	0.1 mSEC

2. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector.
3. Push the PULSE TRAIN left button and set the REPETITION switch to 1 mSEC.
4. Allow triggering and position the start pulse to the left end of the graticule.
5. Slightly rotate the INTEN control counterclockwise.
6. Rotate the DELAY control fully counterclockwise and check that the delay time of the B sweep (intensified portion) from the A sweep start point is within 0.35 div ±0.15 div.
7. Rotate the DELAY control fully clockwise and check that the delay time of the B sweep is within 10.5 div ±0.5 div.
8. If the error is large, rotate the DELAY control fully counterclockwise and adjust R521 START (see Fig. 6-1) to obtain 0.35 div delay time of the B sweep, next, rotate the DELAY control fully clockwise and adjust R523 STOP (see Fig. 6-1) to obtain 10.5 div delay time. Repeat the adjustment of R521 and R523.

—X-Y Operation—

Deflection Factor

Rating

X axis:	±5%
Y axis:	±3%

Check and Calibration

1. Set the controls as follows:

MODE	X-Y
VOLTS/DIV (CH1, CH2)	10mV
VARIABLE (CH1, CH2)	CALIB
AC-GND-DC (CH1, CH2)	DC

2. Connect the 0.6V CAL signal to the CH1 INPUT connector using the accessory probe.
3. Set the trace to the center vertical 6 division area and check that the trace amplitude is within 6 divisions ±3%.
4. Connect the 0.6V CAL signal to the CH2 INPUT connector with the probe.
5. Set the trace to the center horizontal 6 division area and check if the trace amplitude is within 6 divisions ±5%.
6. If the error in item 5 is large, adjust R743 X-Y GAIN (see Fig. 6-1).

Spot Position

Check and Calibration

1. Position the trace start point to the left end line of the graticule.
2. Set the vertical MODE switch to X-Y and check if the spot position is not shifted to the out of the screen.
3. If the spot position is shifted, adjust R744A X-Y POS (see Fig. 6-1).

X-Y Phase Difference

Rating

3° (for DC to 50 kHz)

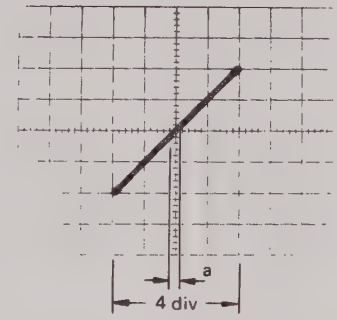
Check

1. Set the controls as shown in item 1 of the above-mentioned "Deflection Factor".
2. Connect the signal of a sine wave generator to the

INPUT connectors of CH1 and CH2 using a BNC-T connector.

3. Set the signal frequency to 50 kHz and adjust the signal output level to set the horizontal amplitude of the Lissajou's pattern to 4 divisions.
4. Check the width "a" in Fig. 6-12 which must be smaller than 0.2 division.

Fig. 6-12 X-Y phase difference



a: Opening on the horizontal center line

NOTES

SECTION 7
SCHEMATIC DIAGRAMS

Voltages and Waveforms

The voltages and waveforms in the normal action of the instrument are shown in the schematic diagrams. These voltages and waveforms are useful for troubleshooting.

The voltages and waveforms are measured by the following condition.

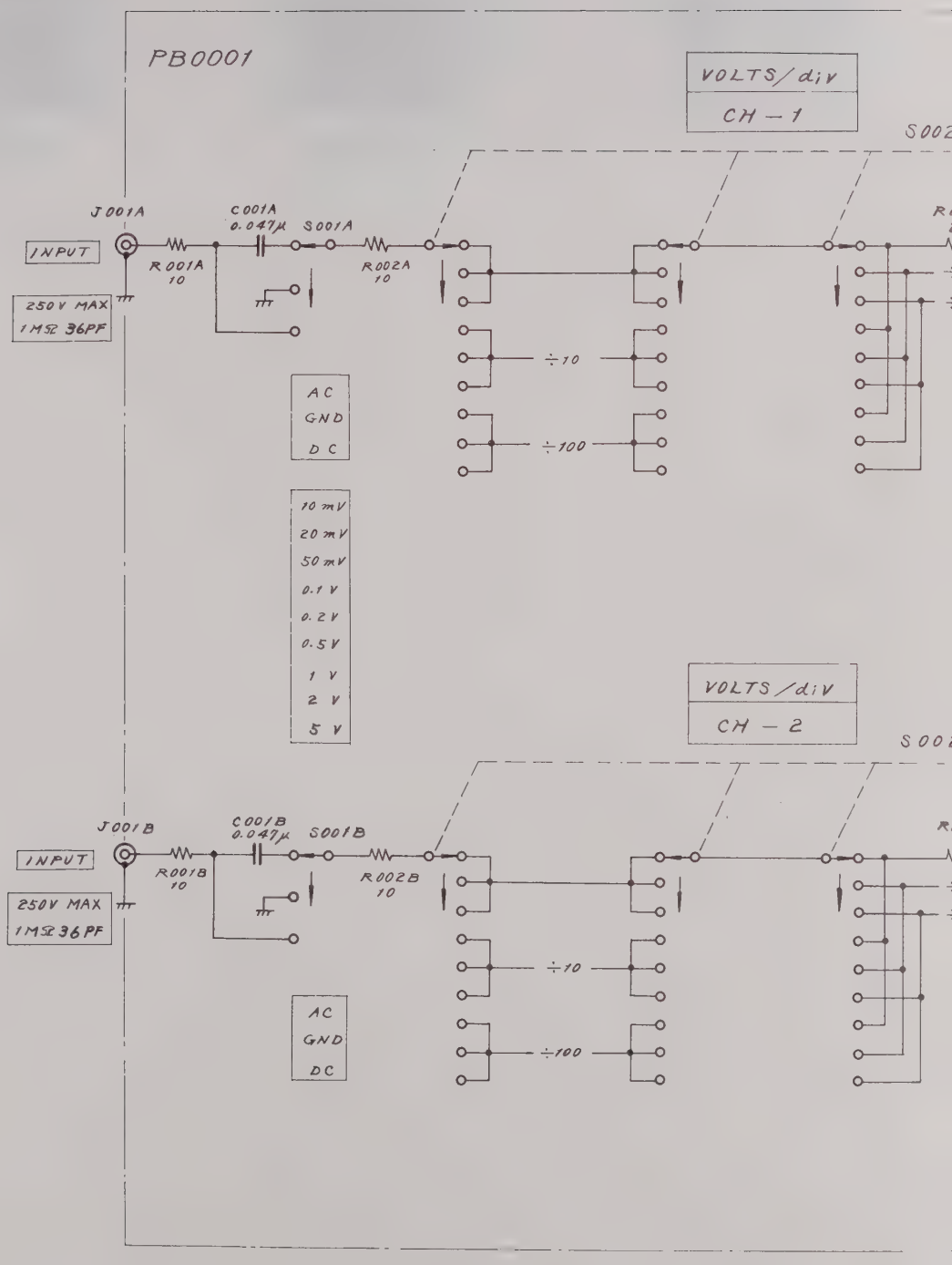
1. The CAL 0.6V signal is connected to the INPUT connector using a 10:1 probe.

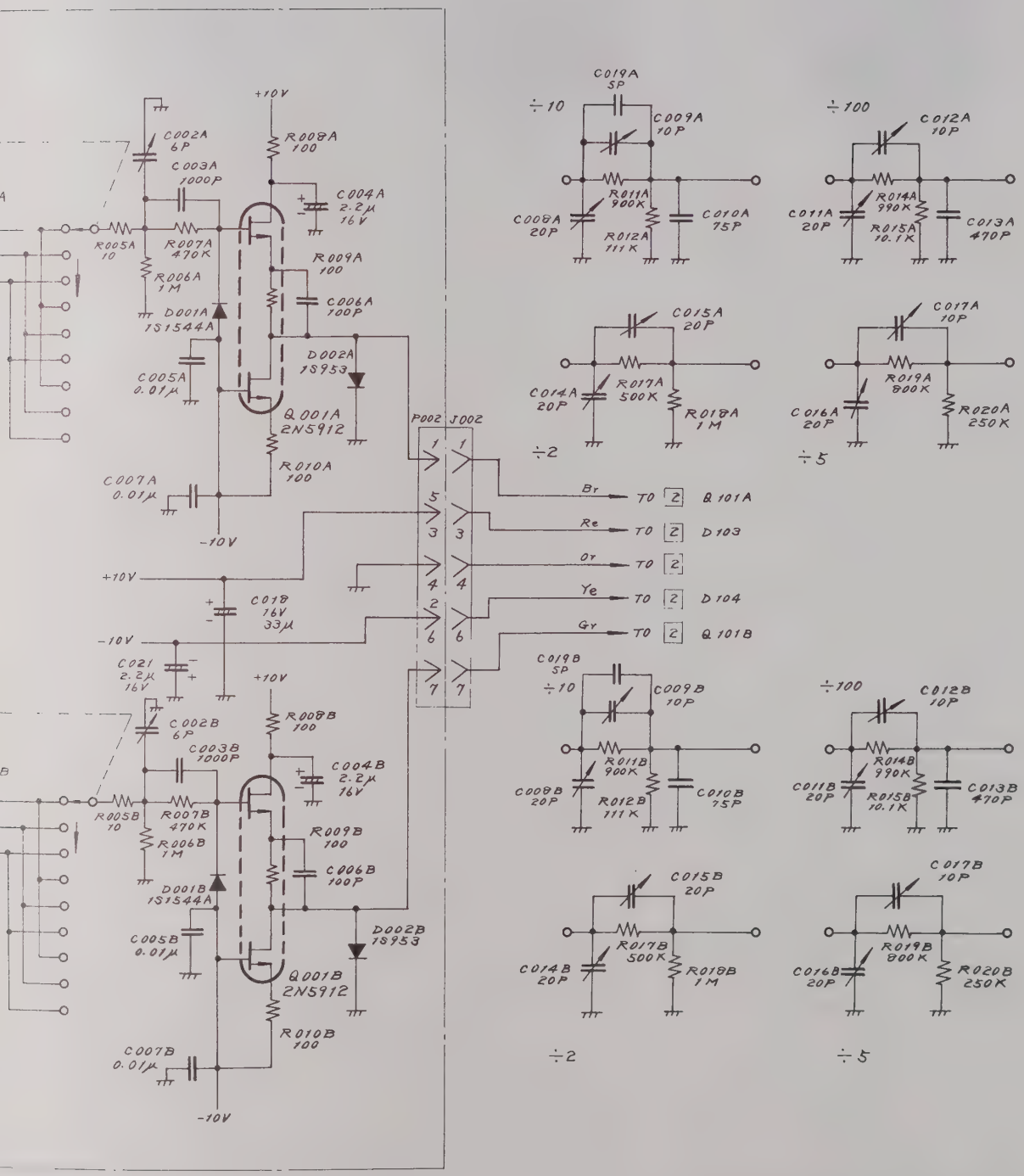
2. The switches and connectors of this instrument are set as follows:

POWER	On (push in)
INTEN	Mid-range
FOCUS	Mid-range
MODE (Vertical)	CH1
VOLTS/DIV (CH1, CH2)	10 mV
VARIABLE (CH1, CH2)	CALIB
POSITION (CH1, CH2)	Mid-range
AC-GND-DC (CH1,CH2)	DC
GAIN (CH1, CH2)	X1
POLARITY (CH2)	NORM
SOURCE	CH1
COUPL	NORM
SLOPE	+
DISP	A
MODE (Sweep)	AUTO
DELAY	Fully counterclockwise
Horizontal Position	Mid-range
Fine (PULL X10)	Push, Mid-range
LEVEL	Mid-range
HOLDOFF	
A TIME/DIV	1 mSEC
B TIME/DIV	0.5 mSEC
A VARIABLE	CALIB
B SWEEP	TRIG
AC-DC	AC

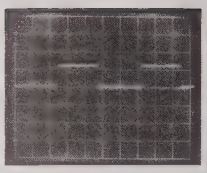
3. Exceptions in the control settings are shown by "VOLTAGE & WAVEFORM READING CONDITIONS" noted on the schematic diagram. The asterisks marked on the diagram show the point measured by the exceptional settings.

4. The waveforms which starting from the negative slope are measured by setting the SLOPE switch of a test oscilloscope to—.

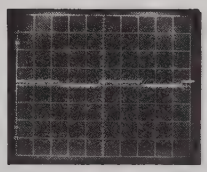

PB0001
VOLTS/div
CH – 1
J001A
INPUT
250V MAX
1MΩ 36PF
C001A
0.047μ
S001A
R001A
10
R002A
10
÷10
÷100
AC
GND
DC
10 mV
20 mV
50 mV
0.1 V
0.2 V
0.5 V
1 V
2 V
5 V
VOLTS/div
CH – 2
J001B
INPUT
250V MAX
1MΩ 36PF
C001B
0.047μ
S001B
R001B
10
R002B
10
÷10
÷100
AC
GND
DC



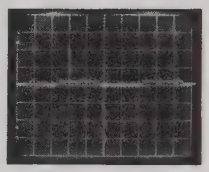
名称 Title SS-3510/SS-3510TV	1
VERTICAL ATTENUATOR	
図番 Drwg No K-606695	2

① 60mV  ≈−5.9V

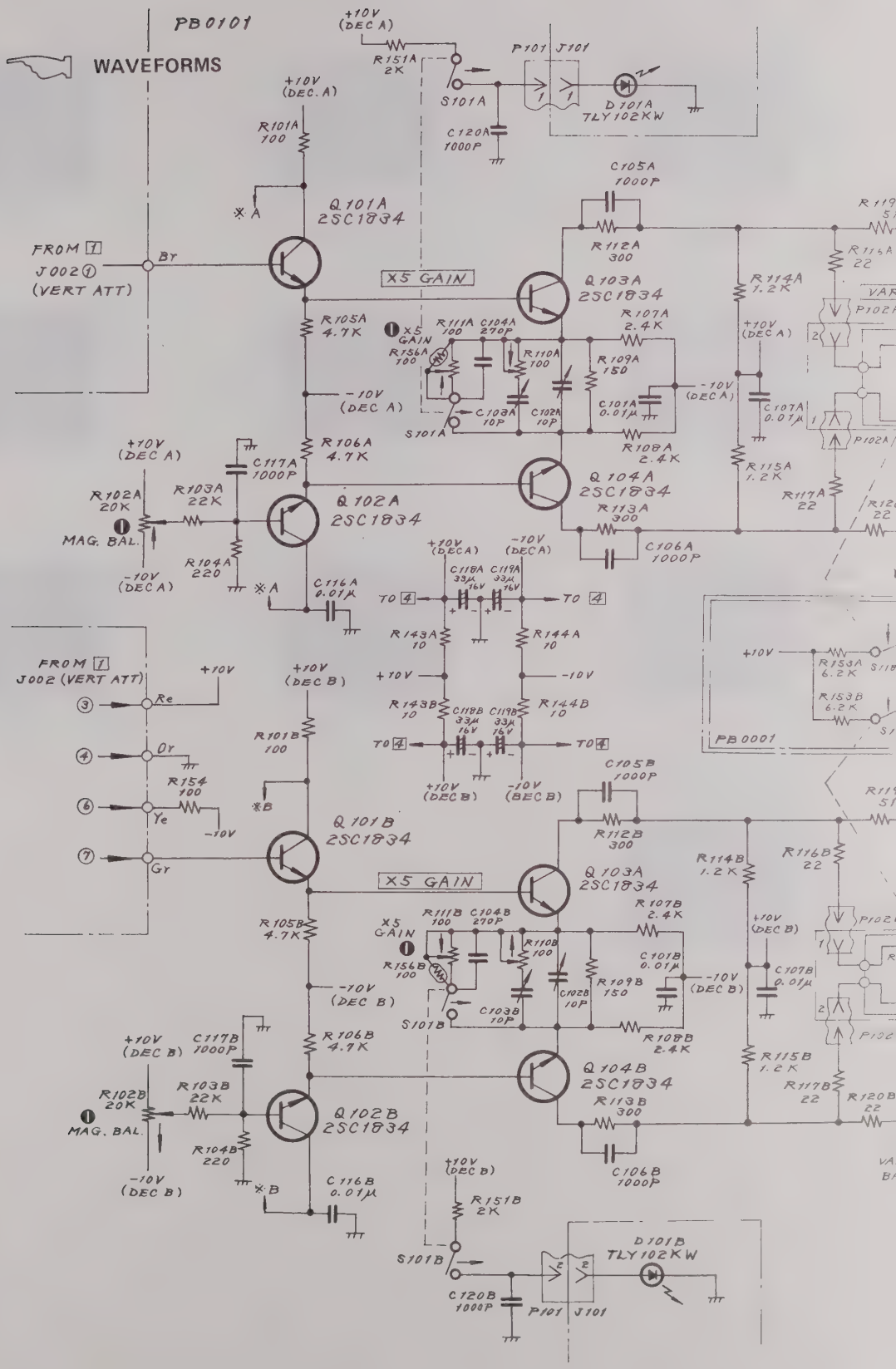
0.2mS
AC COUPLED

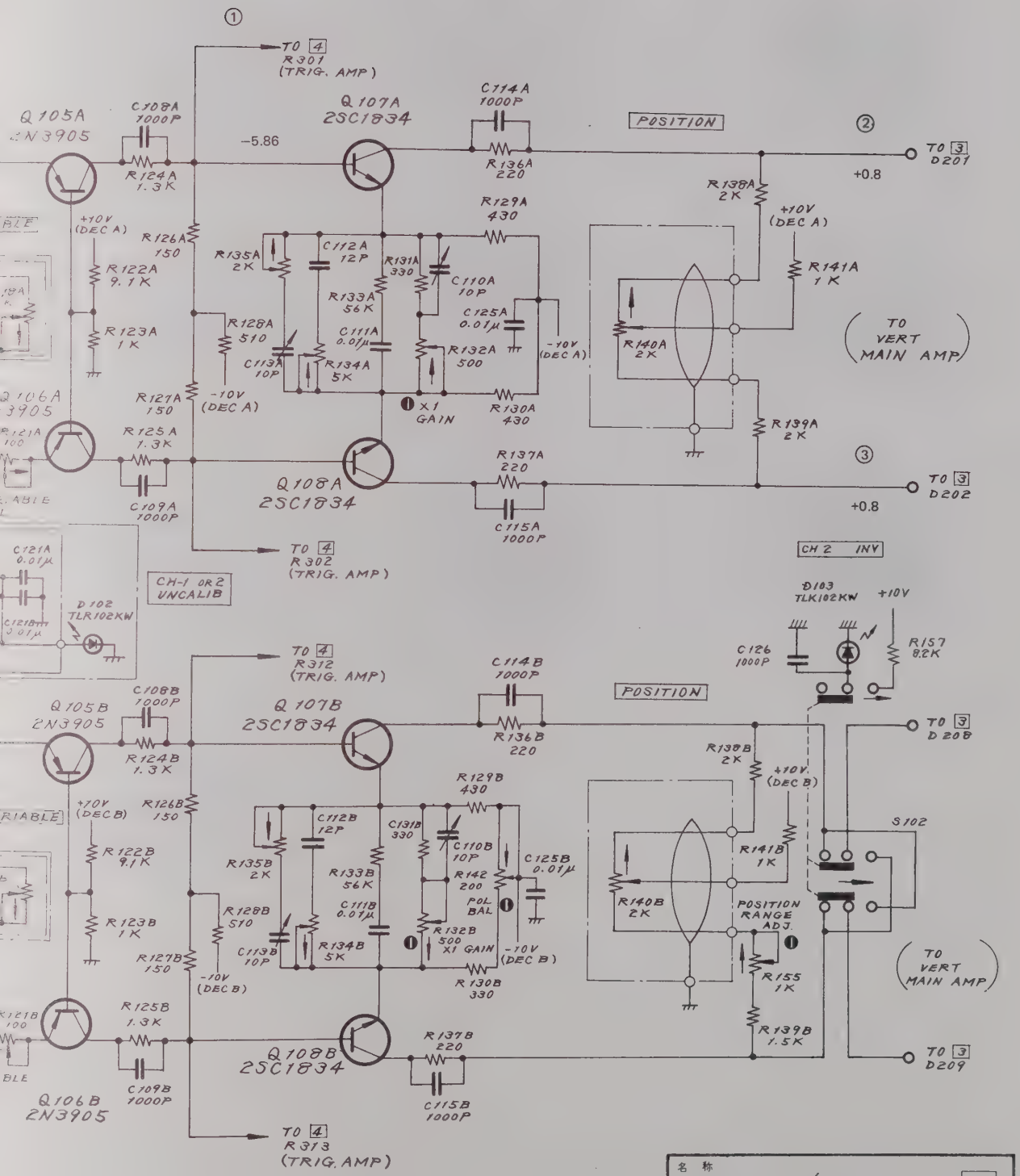
② 10mV  ≈+0.8V

0.2mS
AC COUPLED

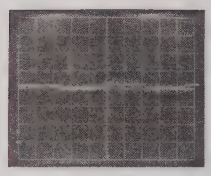
③ 10mV  ≈+0.8V

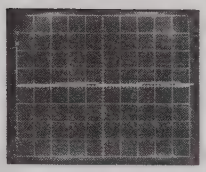
0.2mS
AC COUPLED

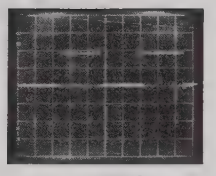

PB0101
WAVEFORMS
FROM 7
J002 1
(VERT ATT)
+10V (DEC A)
-10V (DEC A)
+10V (DEC B)
-10V (DEC B)
R101A 100
R105A 4.7K
R106A 4.7K
R102A 20K
MAG. BAL.
R103A 22K
R104A 220
C117A 1000P
C116A 0.01μ
Q101A 2SC1834
Q102A 2SC1834
R151A 2K
S101A
C120A 1000P
P101 J101
D101A TLY102KW
C105A 1000P
R112A 300
X5 GAIN
Q103A 2SC1834
R111A 100
C104A 270P
R156A 100
C103A 10P
C102A 10P
R110A 100
R109A 150
C101A 0.01μ
R107A 2.4K
R108A 2.4K
Q104A 2SC1834
R113A 300
C106A 1000P
R114A 1.2K
R115A 1.2K
R116A 22
R117A 22
C107A 0.07μ
C118A 33μ 16V
C119A 33μ 16V
TO 4
R143A 10
R144A 10
R143B 10
R144B 10
C118B 33μ 16V
C119B 33μ 16V
FROM 7
J002 (VERT ATT)
Re
Or
Ye
Gr
R154 100
R101B 100
R105B 4.7K
R106B 4.7K
R102B 20K
MAG. BAL.
R103B 22K
R104B 220
C117B 1000P
C116B 0.01μ
Q101B 2SC1834
Q102B 2SC1834
R151B 2K
S101B
C120B 1000P
D101B TLY102KW
C105B 1000P
R112B 300
X5 GAIN
Q103A 2SC1834
R111B 100
C104B 270P
R156B 100
C103B 10P
C102B 10P
R110B 100
R109B 150
C101B 0.01μ
R107B 2.4K
R108B 2.4K
Q104B 2SC1834
R113B 300
C106B 1000P
R114B 1.2K
R115B 1.2K
R116B 22
R117B 22
C107B 0.01μ
PB0001
R153A 6.2K
R153B 6.2K

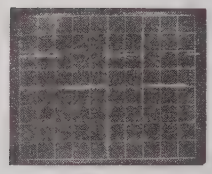


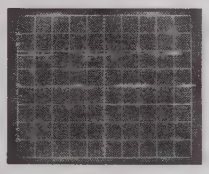
名称 Title	SS-3510/SS-3510TV 2 VERTICAL PREAMPLIFIER
図番 Drwg No	K-606696 2

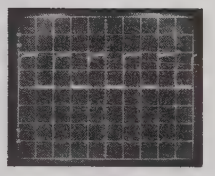
① 10mV  ≈+1.5V
0.2mS
AC COUPLED

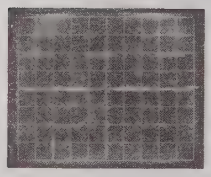
② 5mV  ≈+1.5V
0.2mS
AC COUPLED

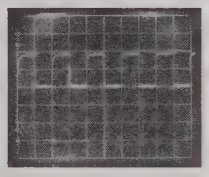
③ 9V  ≈+23V
0.2mS

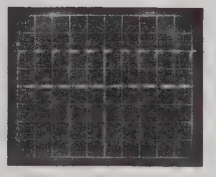
④ 9V  ≈+25V
0.2mS

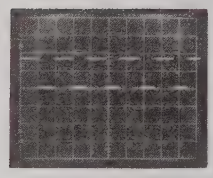
*⑤ 3.6V  ≈+1V
10mS

**⑥ 3.6V  ≈+1V
2μS

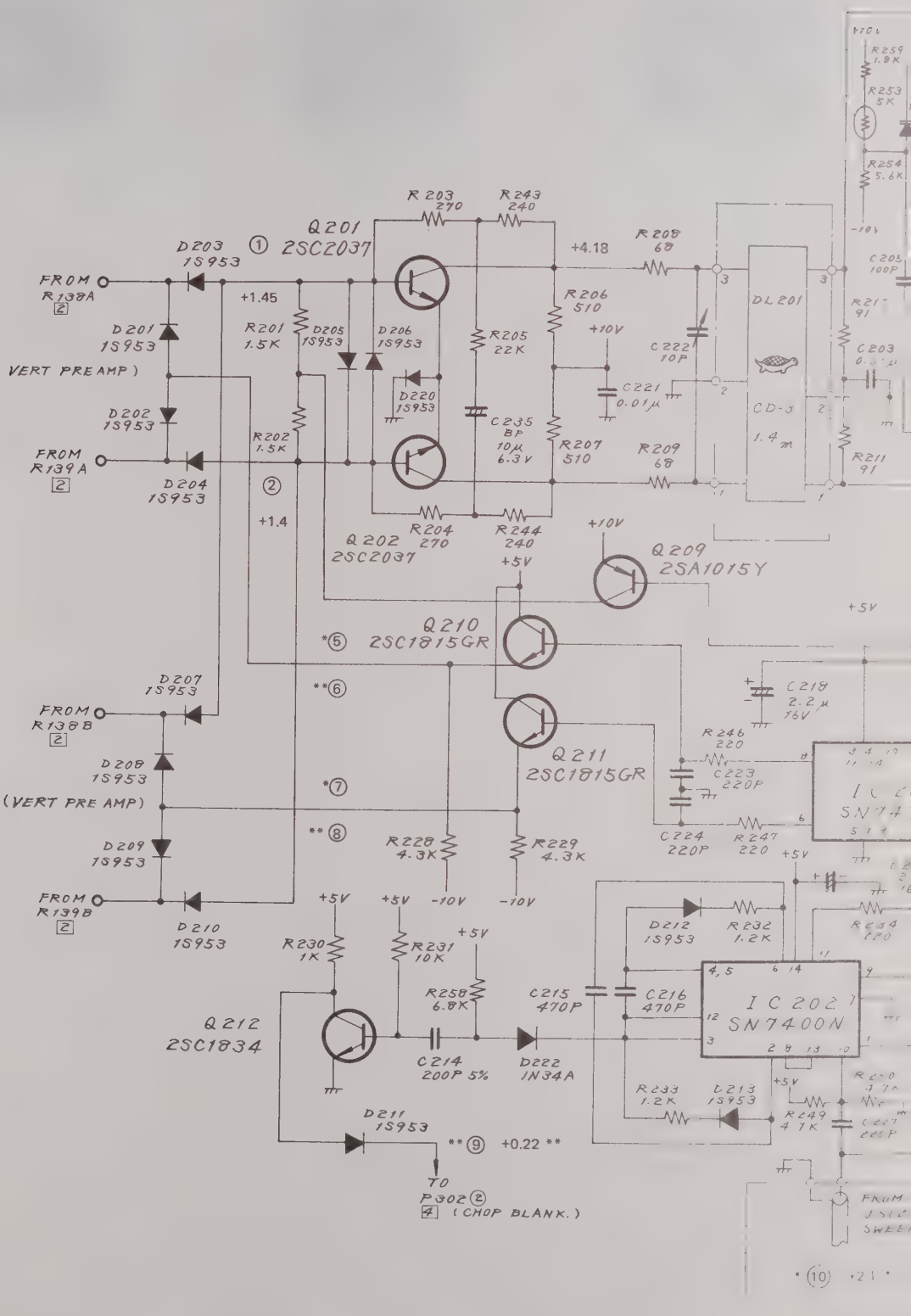
*⑦ 3.6V  ≈+1V
10mS

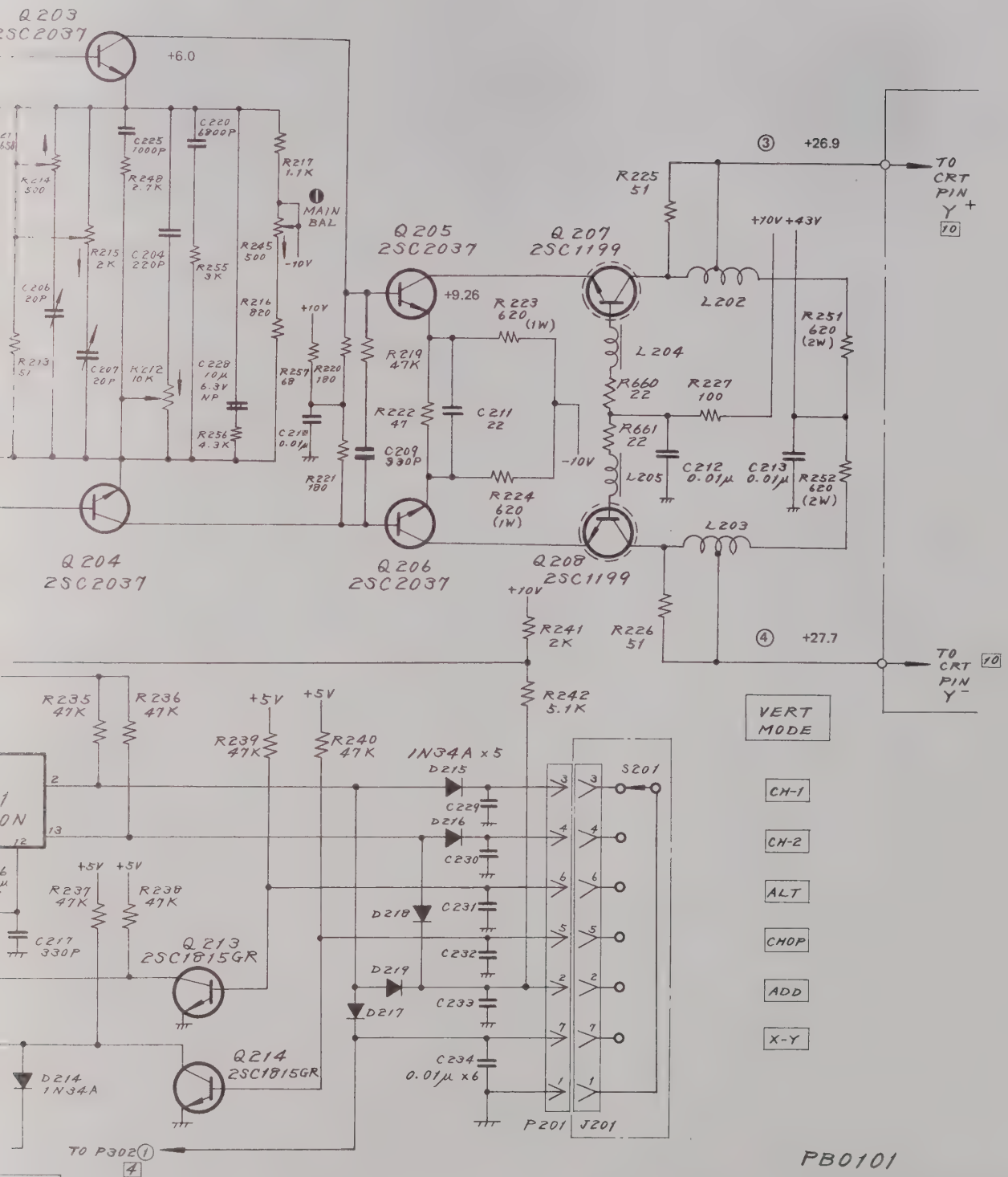
**⑧ 3.6V  ≈+1V
2μS

**⑨ 1V  0V
2μS

*⑩ 3.5V  ≈+0.3V
10mS

WAVEFORMS

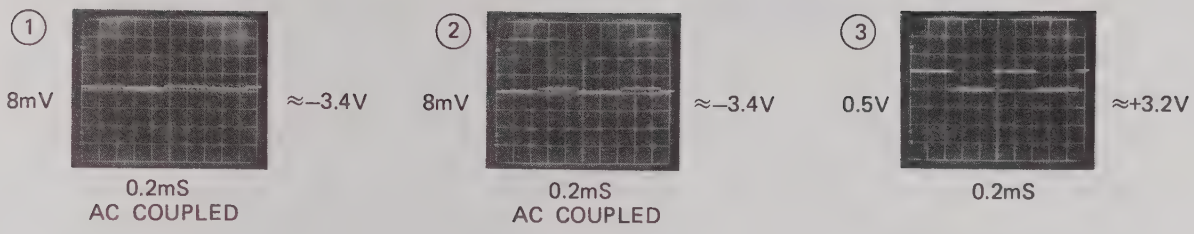

Q201 2SC2037
Q202 2SC2037
Q209 2SA1015Y
Q210 2SC1815GR
Q211 2SC1815GR
Q212 2SC1834
IC 202 SN7400N
D203 1S953
D201 1S953
D205 1S953
D206 1S953
D220 1S953
D202 1S953
D204 1S953
D207 1S953
D208 1S953
D209 1S953
D210 1S953
D212 1S953
D213 1S953
D211 1S953
D222 1N34A
R 203 270
R243 240
R 208 68
R206 510
R205 22K
R201 1.5K
R202 1.5K
R207 510
R209 68
R204 270
R244 240
R246 220
R247 220
R228 4.3K
R229 4.3K
R230 1K
R231 10K
R258 6.8K
R232 1.2K
R233 1.2K
C222 10P
C221 0.01μ
C235 BP 10μ 6.3V
C218 2.2μ 16V
C223 220P
C224 220P
C215 470P
C216 470P
C214 200P 5%
DL 201
CD-3 1.4m
FROM R138A
FROM R139A
FROM R138B
FROM R139B
VERT PREAMP)
(VERT PRE AMP)
+1.45
+1.4
+4.18
+10V
+5V
-10V
+0.22 **
TO P302 (CHOP BLANK.)



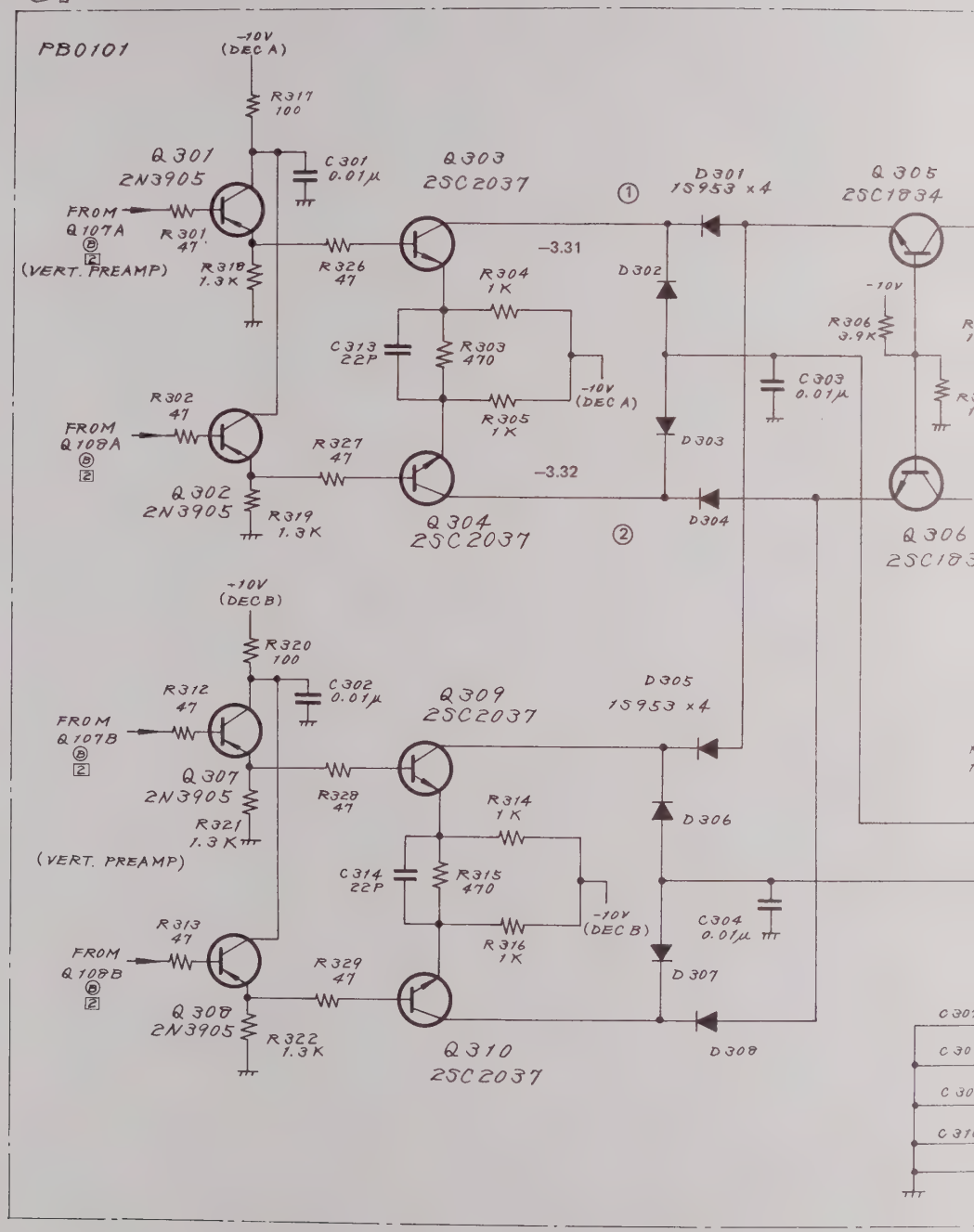
PB0101

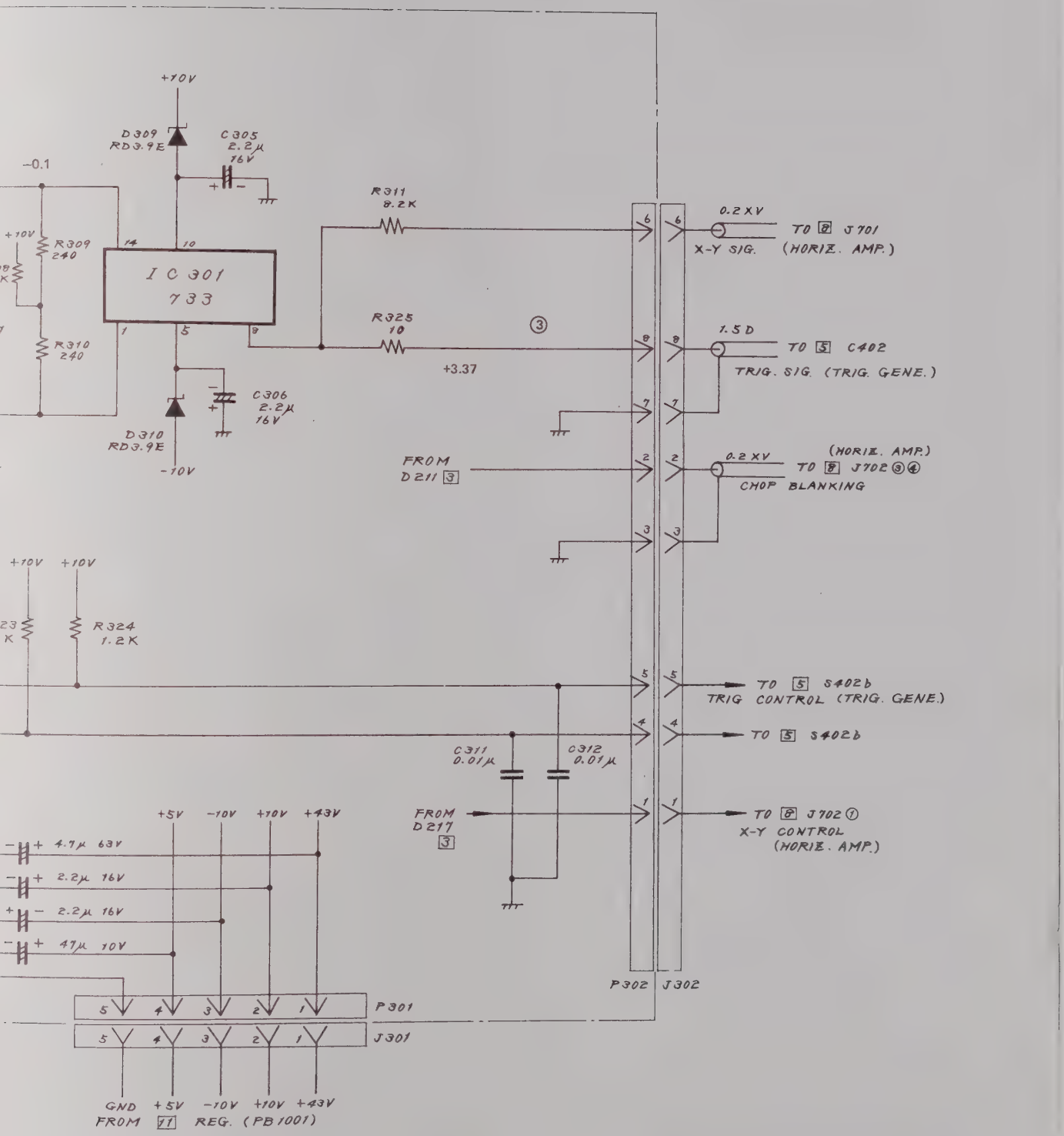
VOLTAGE & WAVEFORM READING CONDITIONS
* MODE ..... ALT
** MODE ..... CHOP

名称 Title SS-3510/SS-3510TV VERTICAL MAIN AMPLIFIER	3
Drwg No K-606697	2

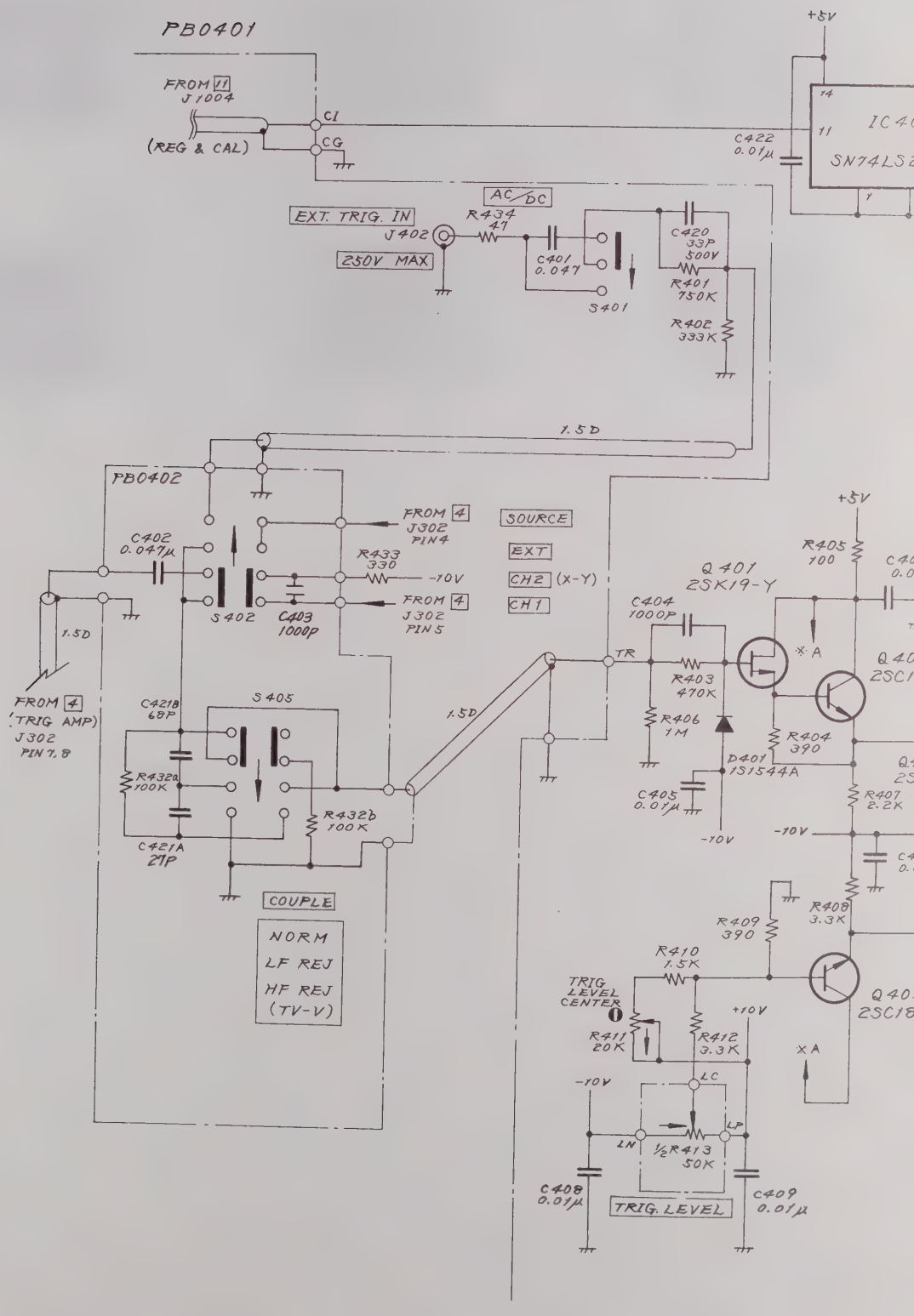

①
8mV
≈–3.4V
0.2mS
AC COUPLED
②
8mV
≈–3.4V
0.2mS
AC COUPLED
③
0.5V
≈+3.2V
0.2mS

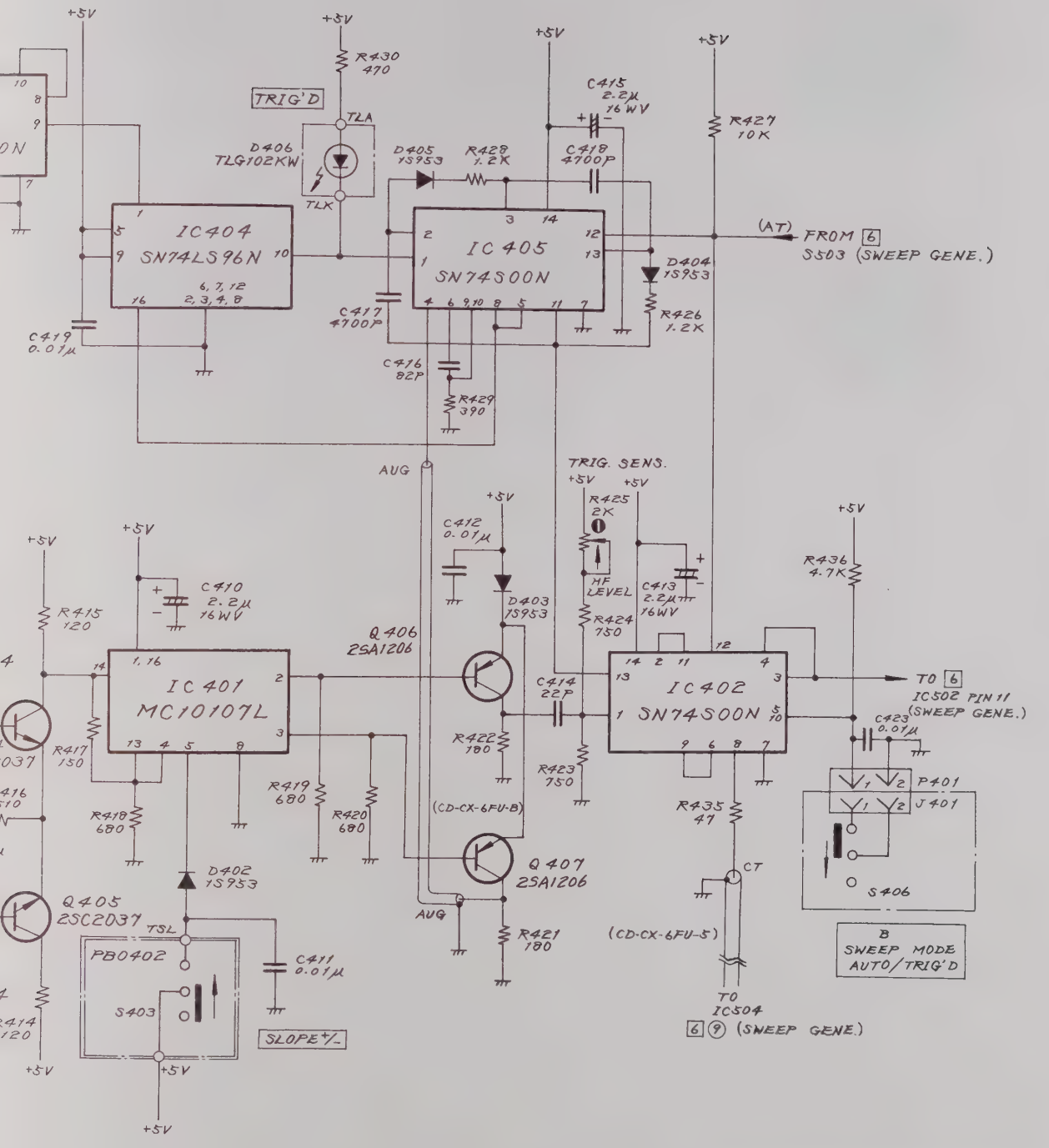
WAVEFORMS


PB0101
-10V (DEC A)
R317 100
Q301 2N3905
C301 0.01μ
Q303 2SC2037
D301 1S953 ×4
Q305 2SC1834
FROM Q107A
R301 47
(VERT. PREAMP)
R318 1.3K
R326 47
-3.31
R304 1K
D302
-10V
R306 3.9K
C313 22P
R303 470
-10V (DEC A)
C303 0.01μ
R302 47
FROM Q108A
R305 1K
D303
R327 47
-3.32
Q302 2N3905
R319 1.3K
Q304 2SC2037
D304
Q306 2SC183
-10V (DEC B)
R320 100
C302 0.01μ
D305 1S953 ×4
R312 47
Q309 2SC2037
FROM Q107B
Q307 2N3905
R328 47
R314 1K
D306
R321 1.3K
(VERT. PREAMP)
C314 22P
R315 470
-10V (DEC B)
C304 0.01μ
R313 47
R316 1K
FROM Q108B
R329 47
D307
Q308 2N3905
R322 1.3K
Q310 2SC2037
D308



名称 Title	SS-3510/SS-3510TV 4 TRIGGER AMPLIFIER
図番 Drwg No	K-606698 1

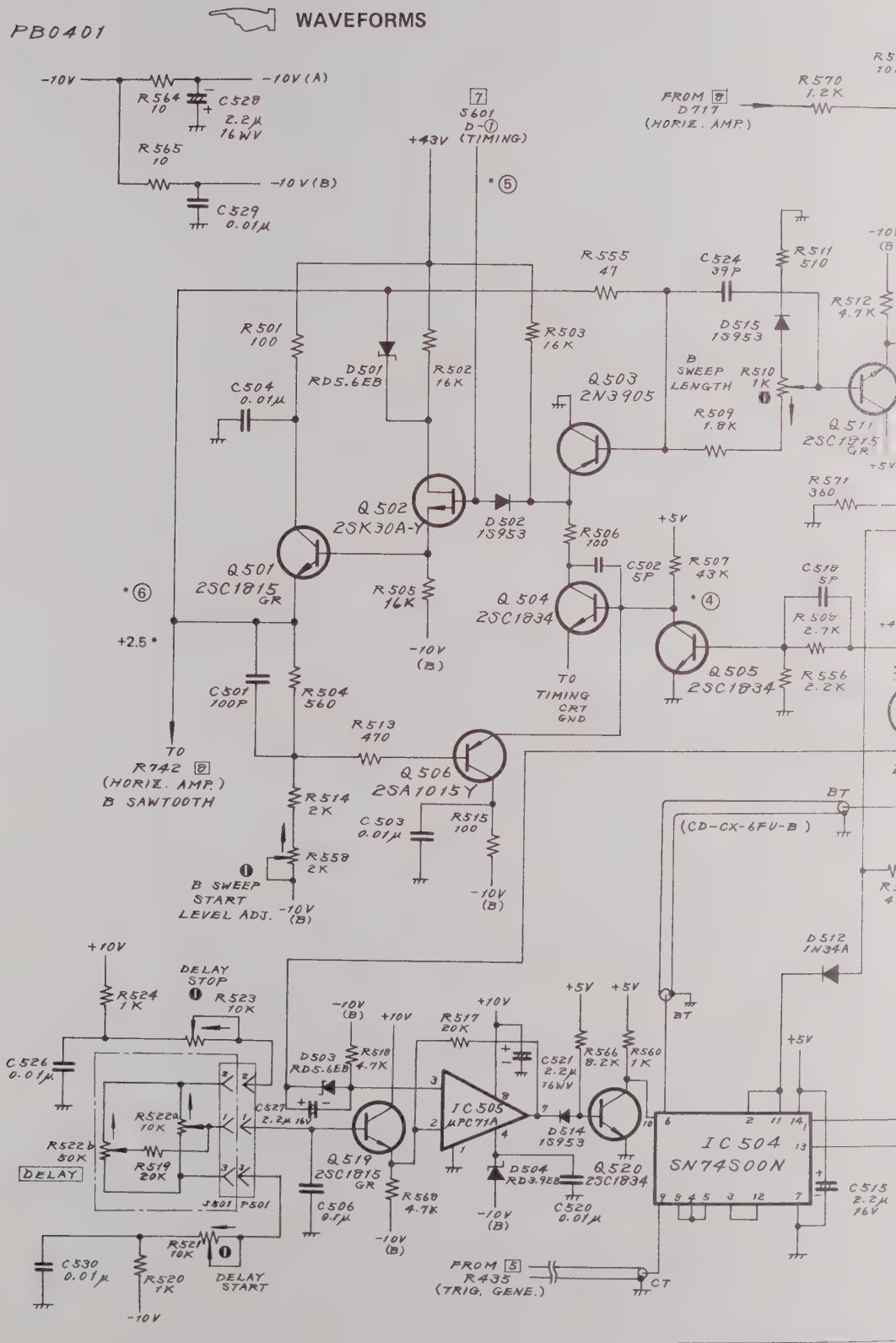

PB0401
FROM 11 J1004
(REG & CAL)
CI
CG
+5V
14
11
IC 4
SN74LS2
C422 0.01μ
AC/DC
EXT. TRIG. IN
J402
250V MAX
R434 47
C401 0.047
S401
C420 33P 500V
R401 750K
R402 333K
1.5D
PB0402
FROM 4 J302 PIN4
SOURCE
EXT
CH2 (X-Y)
CH1
C402 0.047μ
R433 330
-10V
FROM 4 J302 PIN5
S402
C403 1000P
FROM 4 (TRIG AMP) J302 PIN 7, 8
C421B 68P
S405
R432a 100K
R432b 100K
C421A 27P
COUPLE
NORM
LF REJ
HF REJ
(TV-V)
Q401 2SK19-Y
C404 1000P
TR
R403 470K
R406 1M
D401 1S1544A
C405 0.01μ
R405 100
R404 390
R407 2.2K
R408 3.3K
R409 390
R410 1.5K
TRIG LEVEL CENTER
R411 20K
R412 3.3K
+10V
LC
LP
LN
½R413 50K
C408 0.01μ
C409 0.01μ
TRIG. LEVEL



名称 Title	SS-3510 TRIGGER GENERATOR	5
図番 Drawing No.	K-606774	2

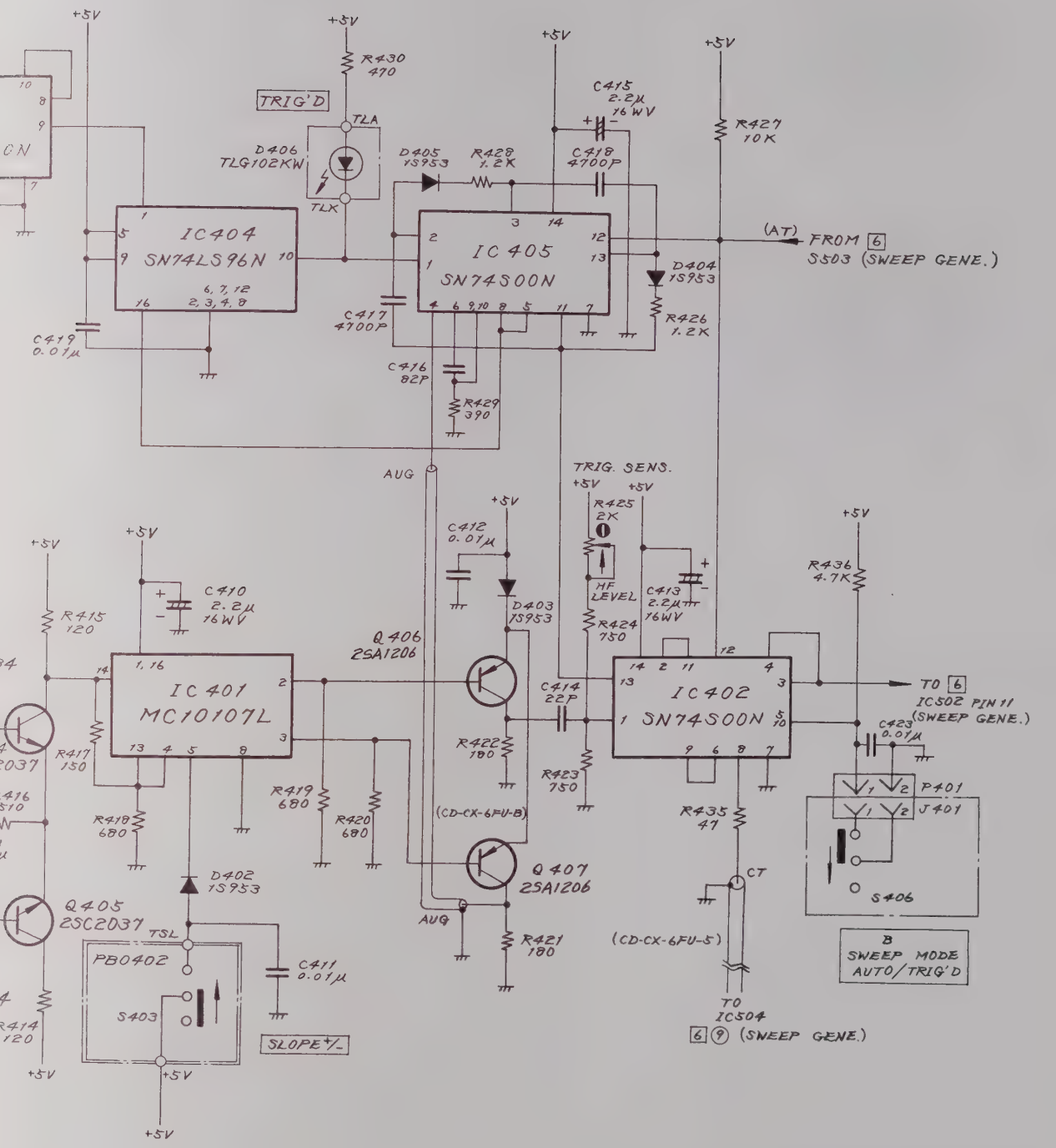
PB0401

WAVEFORMS

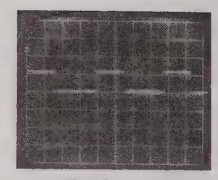


VOLTAGE & WAVEFORM

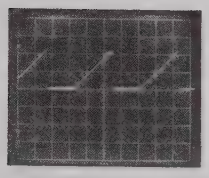
* DISP .....



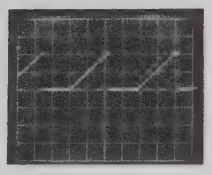
SS-3510	5
TRIGGER GENERATOR	
K-606774	2

① 0.6V  ≈+0.1V

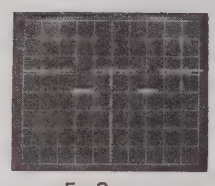
5mS

② 11V  ≈+2V

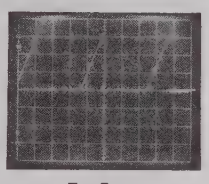
5mS

③ 10V  ≈+2V

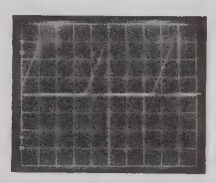
5mS

*④ 0.6V  ≈+80mV

5mS

*⑤ 5.6V  ≈+1.2V

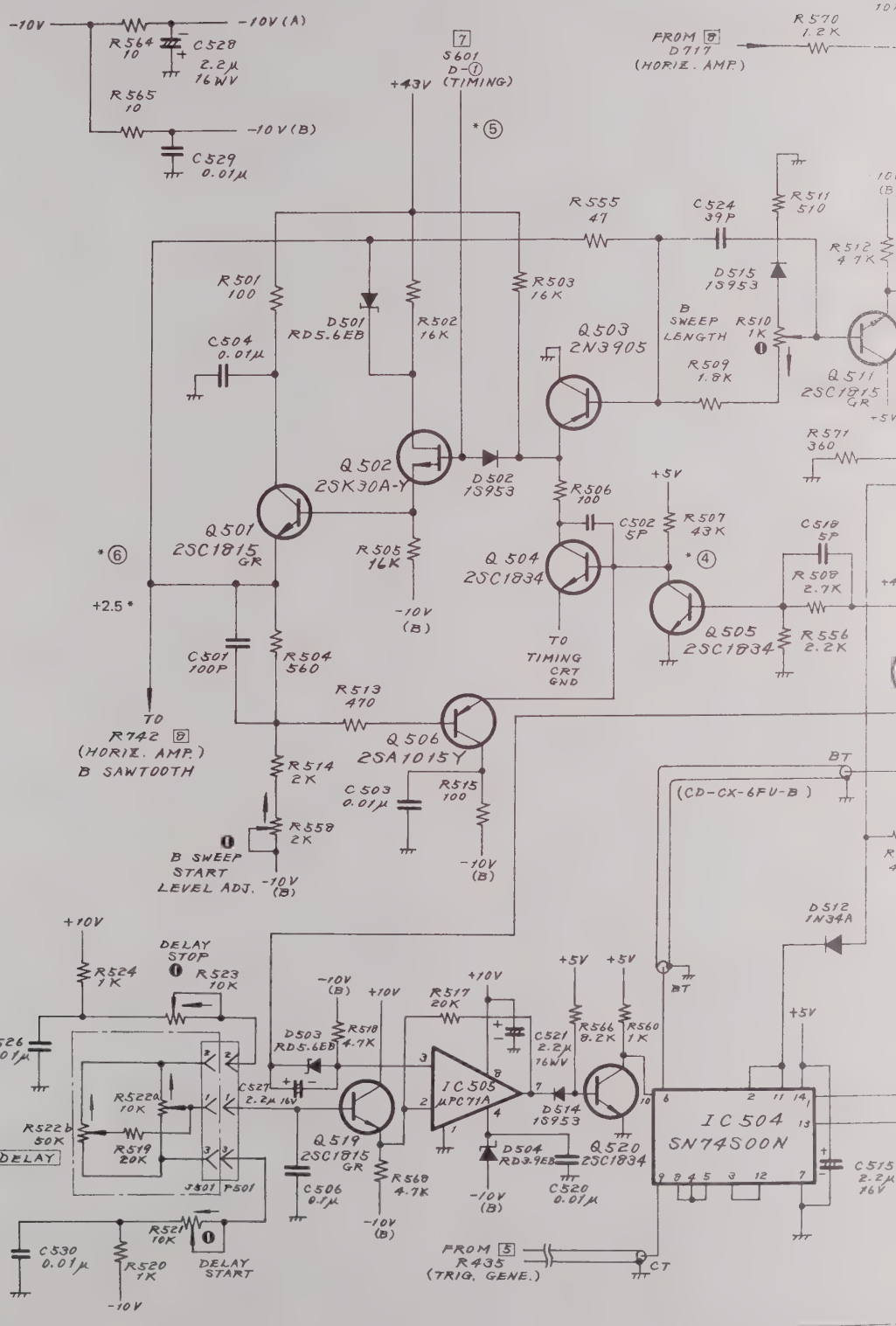
5mS

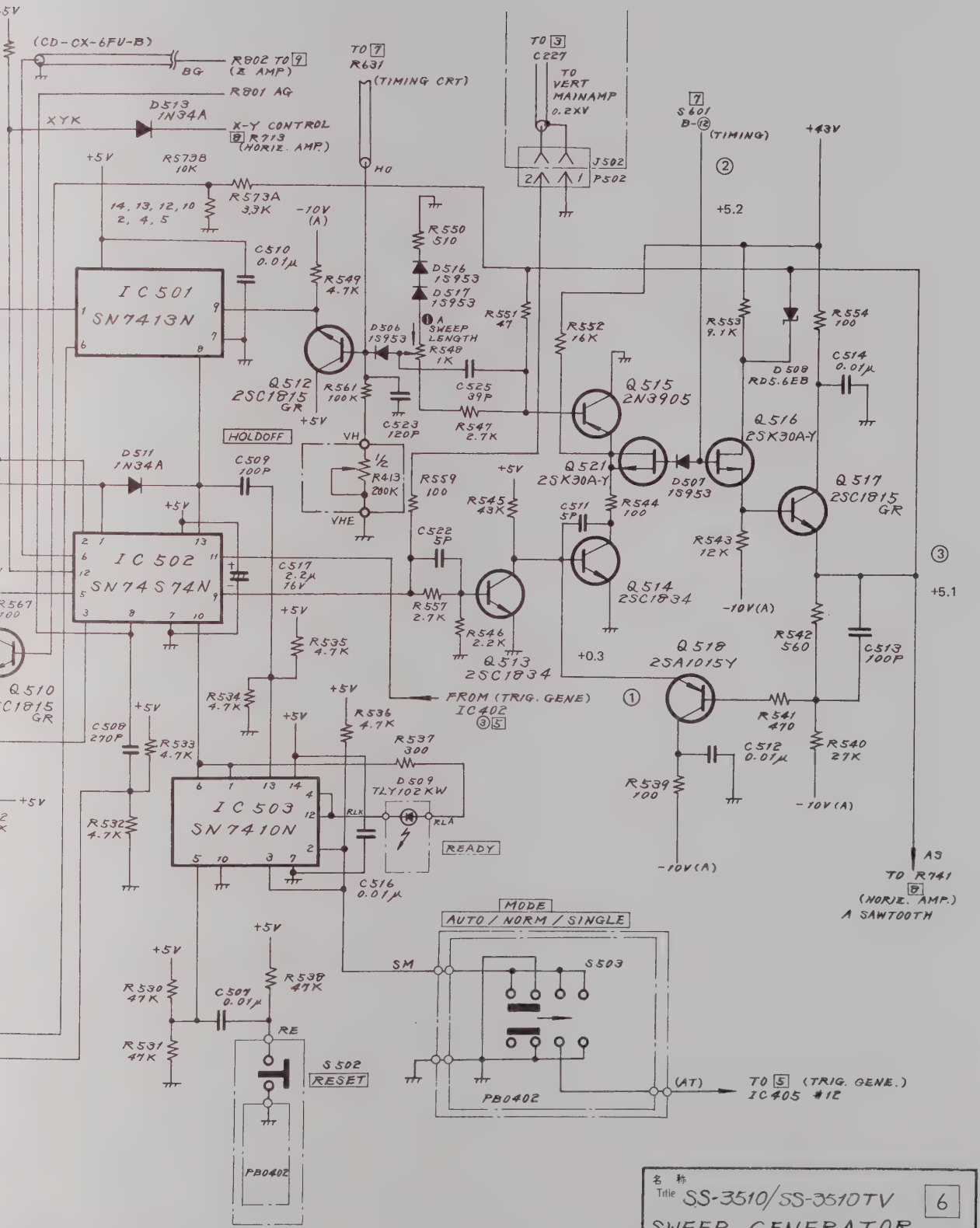
*⑥ 5.6V  ≈+1.8V

5mS

PB0401

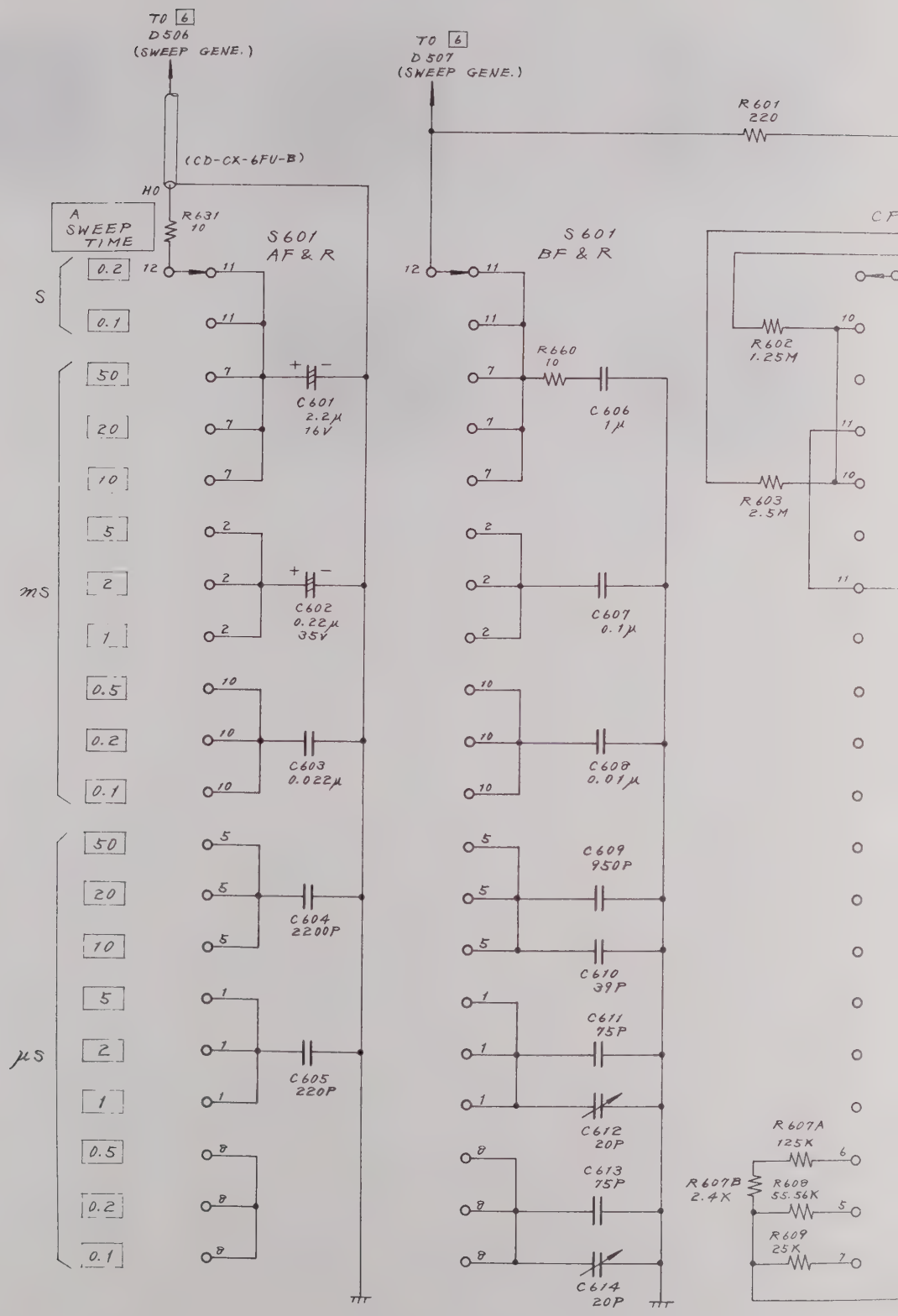
WAVEFORMS

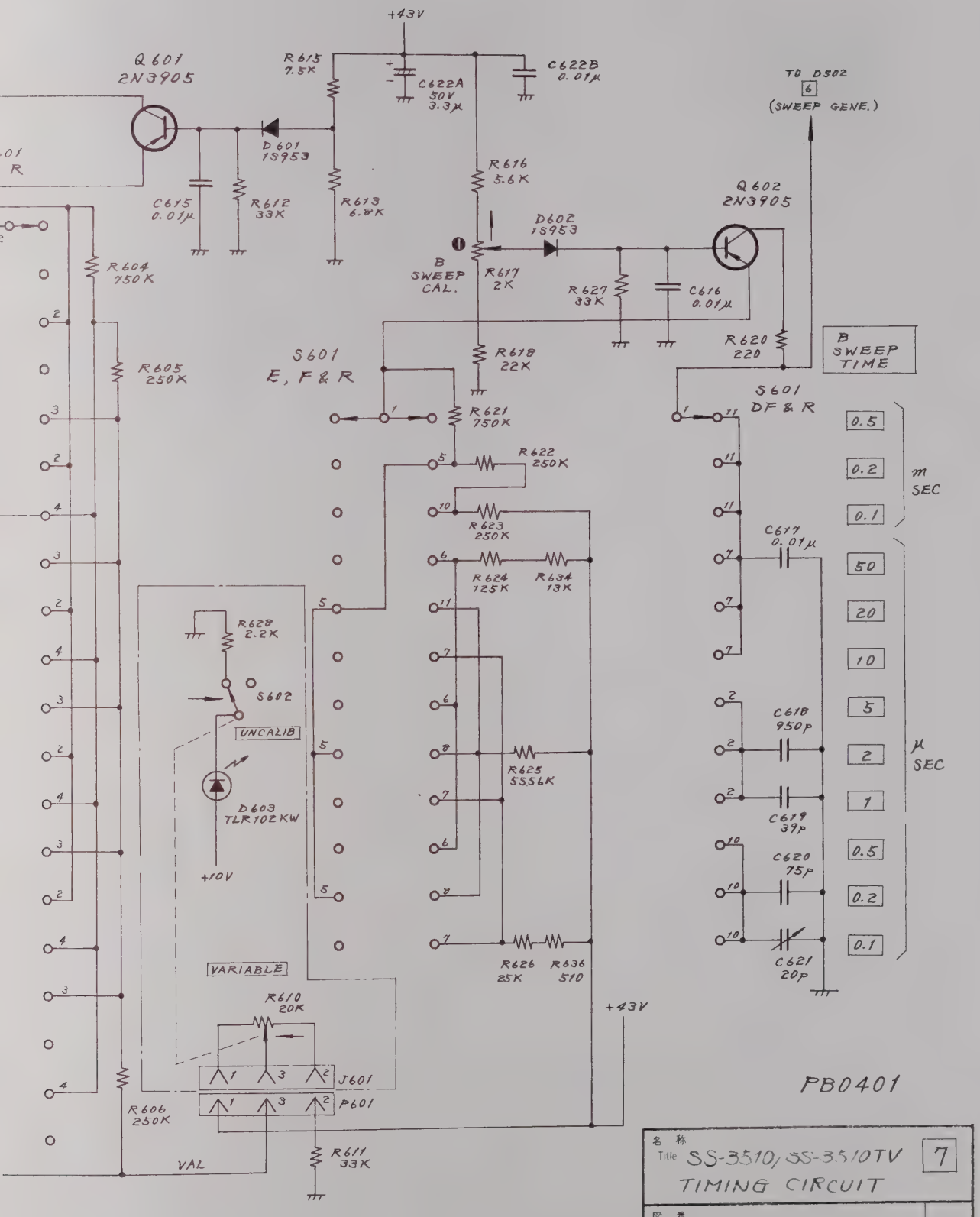




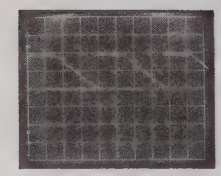
READING CONDITIONS
..... B

名称 Title SS-3510/SS-3510TV SWEEP GENERATOR	6
図番 Drwg No K-606700	3

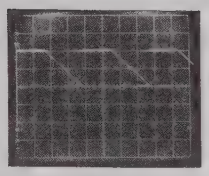

TO 6
D506
(SWEEP GENE.)
(CD-CX-6FU-B)
H0
A
SWEEP
TIME
R631
10
S601
AF & R
S
ms
μs
0.2
0.1
50
20
10
5
2
1
0.5
0.2
0.1
50
20
10
5
2
1
0.5
0.2
0.1
C601
2.2μ
16V
C602
0.22μ
35V
C603
0.022μ
C604
2200P
C605
220P
TO 6
D507
(SWEEP GENE.)
R601
220
S601
BF & R
R660
10
C606
1μ
C607
0.1μ
C608
0.01μ
C609
950P
C610
39P
C611
75P
C612
20P
C613
75P
C614
20P
R602
1.25M
R603
2.5M
R607A
125K
R607B
2.4K
R608
55.56K
R609
25K



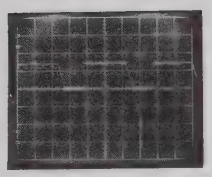
名称 Title	SS-3510, SS-3510TV / TIMING CIRCUIT — 7
図番 Drwg No	K-606701 — 2

① 1.9V  ≈+4V

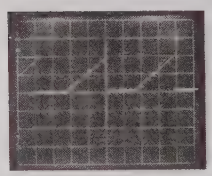
5mS

② 40V  ≈+18V

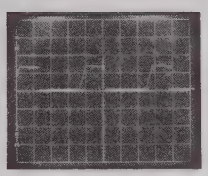
5mS

*③ 70V  ≈+10V

5mS

④ 39V  ≈+30V

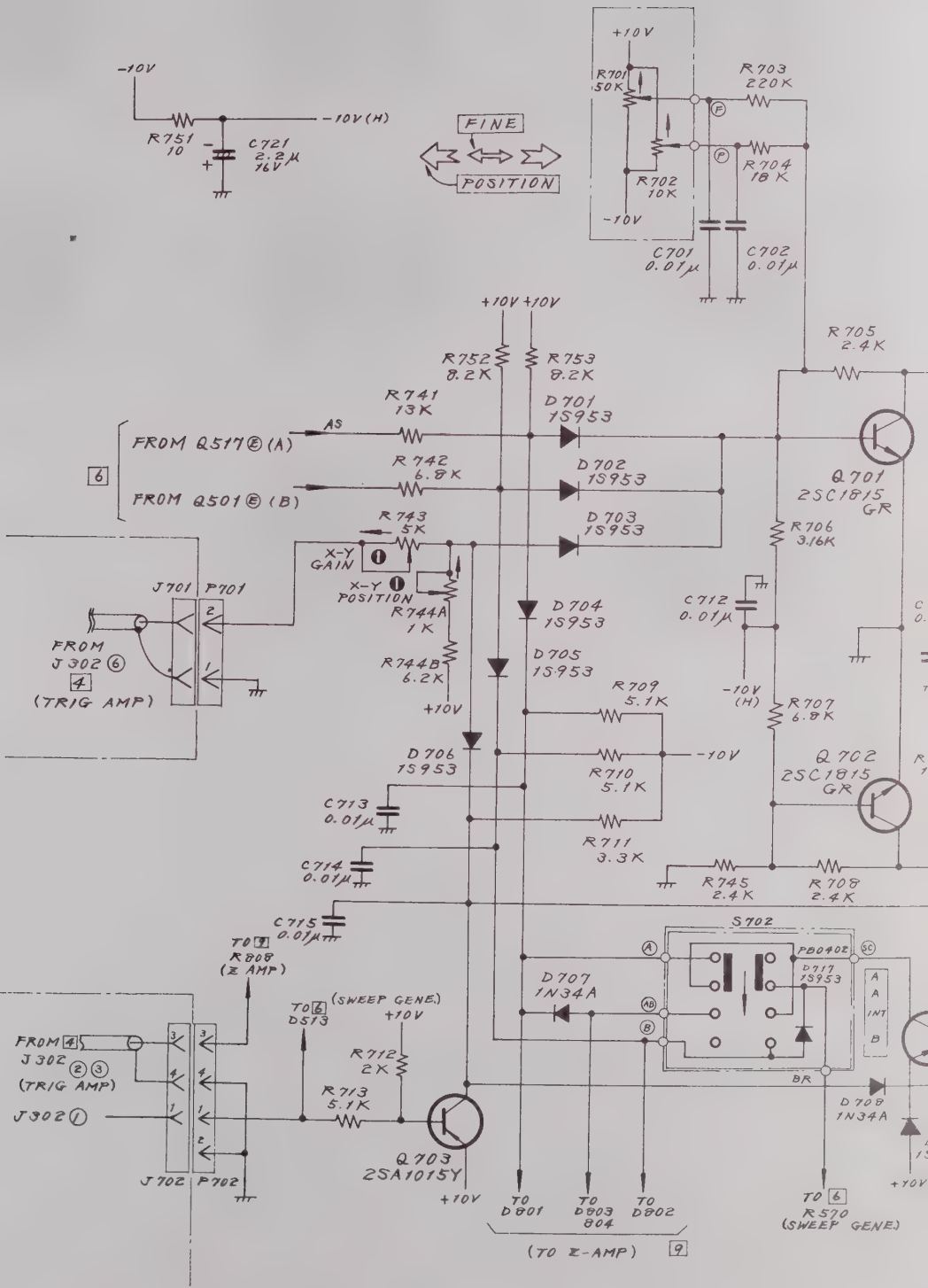
5mS

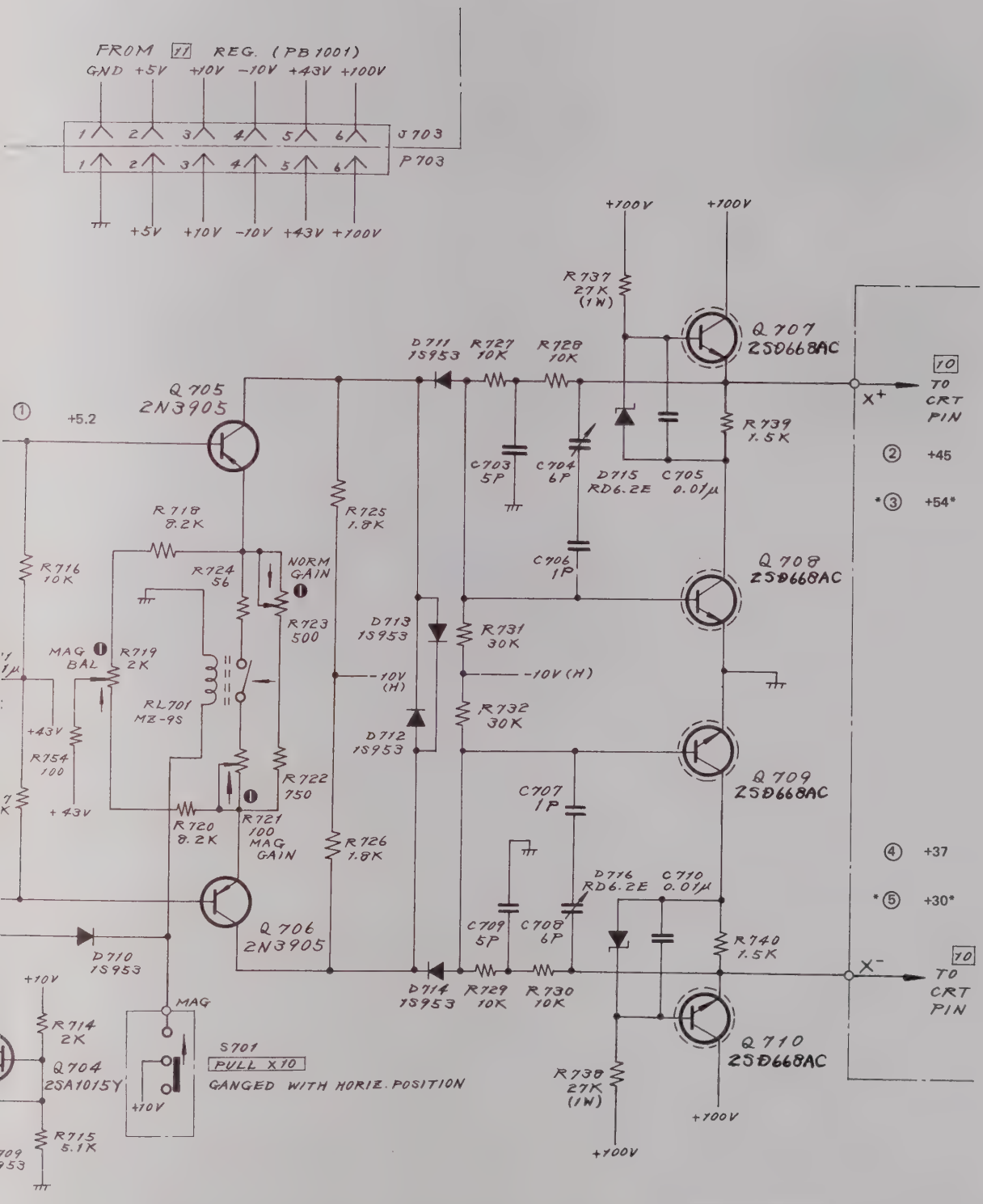
*⑤ 60V  ≈+10V

5mS

WAVEFORMS

PB0401

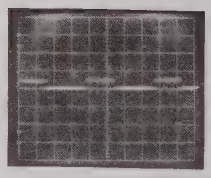




VOLTAGE & WAVEFORM READING CONDITIONS
* PULL X10 ..... Pull

名称 Title SS-3510/SS-3510TV HORIZONTAL AMPLIFIER	8
図番 Drwg No K-606702	4

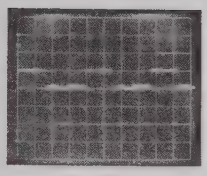
①



20mV 0V

5mS

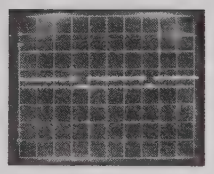
*②



50mV 0V

5mS

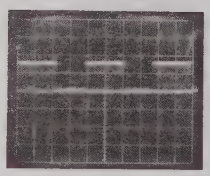
**③



20mV 0V

5mS

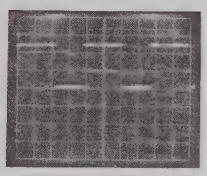
***④



0.8V 0V

5mS

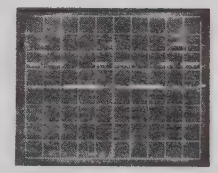
⑤



24V ≈+5V

5mS

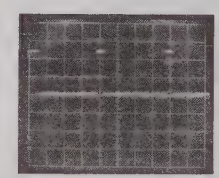
*⑥



24V ≈+5V

5mS

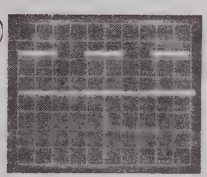
**⑦



24V ≈+5V

5mS

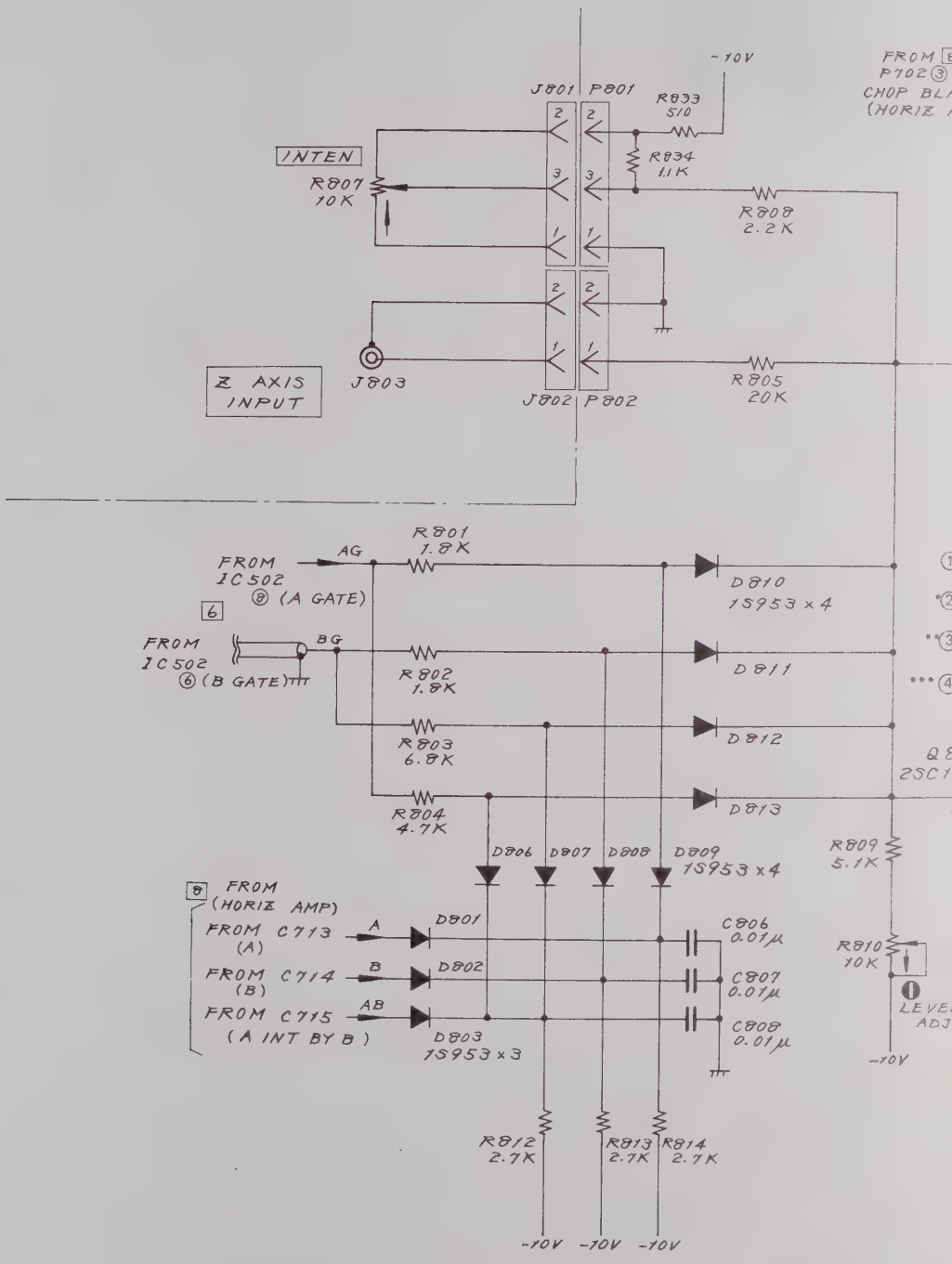
***⑧

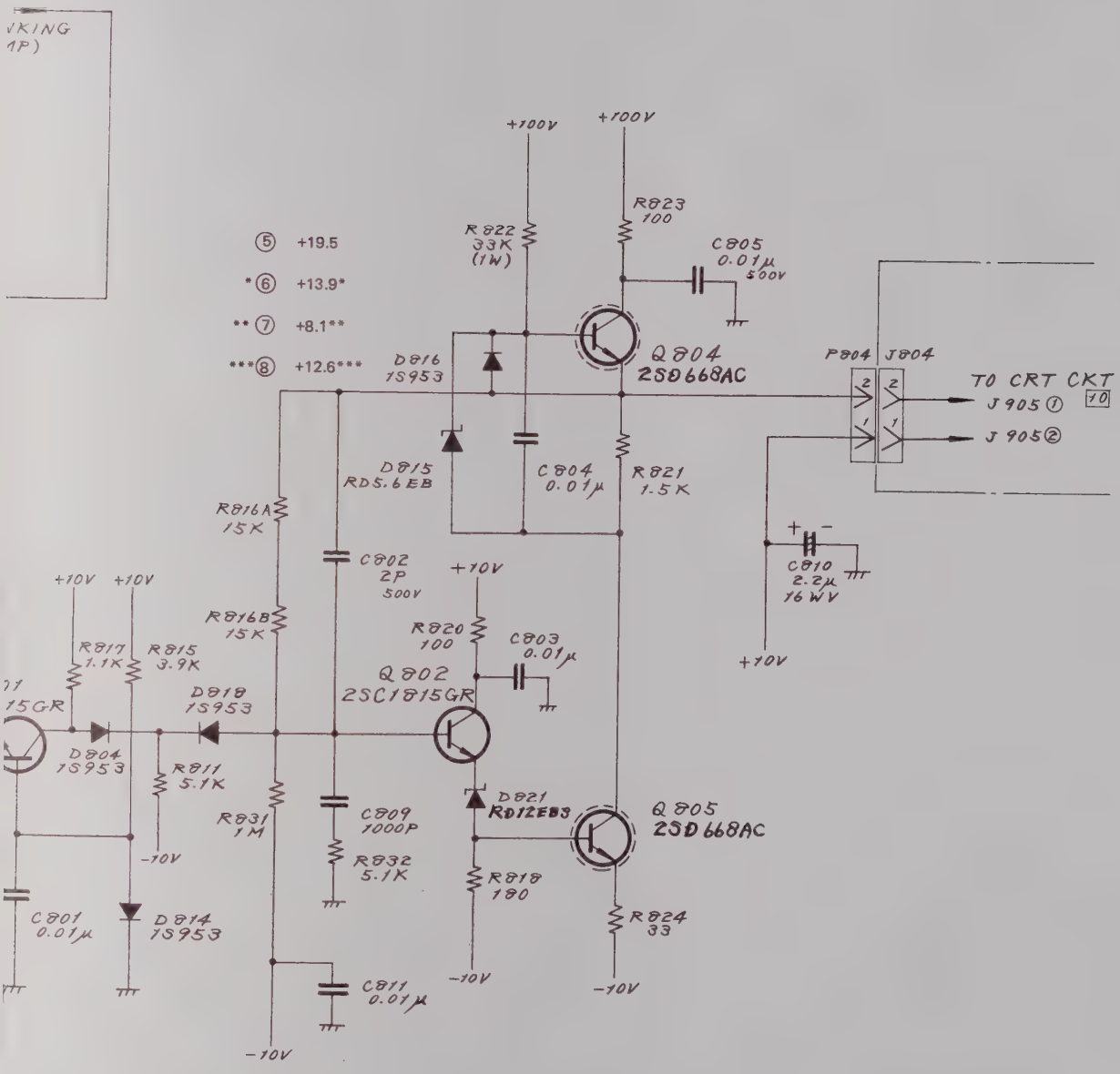


24V ≈+5V

5mS

WAVEFORMS

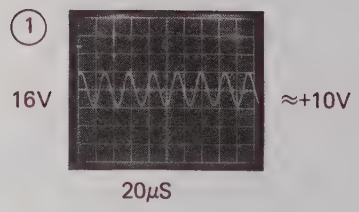

-10V
J801
P801
R833
510
INTEN
R834
1.1K
R807
10K
R808
2.2K
Z AXIS
INPUT
J803
J802
P802
R805
20K
R801
1.8K
FROM
IC502
⑧ (A GATE)
AG
D810
1S953 x 4
FROM
IC502
⑥ (B GATE)
BG
R802
1.8K
D811
R803
6.8K
D812
R804
4.7K
D813
D806
D807
D808
D809
1S953 x4
R809
5.1K
FROM
(HORIZ AMP)
FROM C713
(A)
A
D801
C806
0.01μ
FROM C714
(B)
B
D802
C807
0.01μ
FROM C715
(A INT BY B)
AB
D803
1S953 x3
C808
0.01μ
R810
10K
-10V
R812
2.7K
R813
2.7K
R814
2.7K
-10V
-10V
-10V



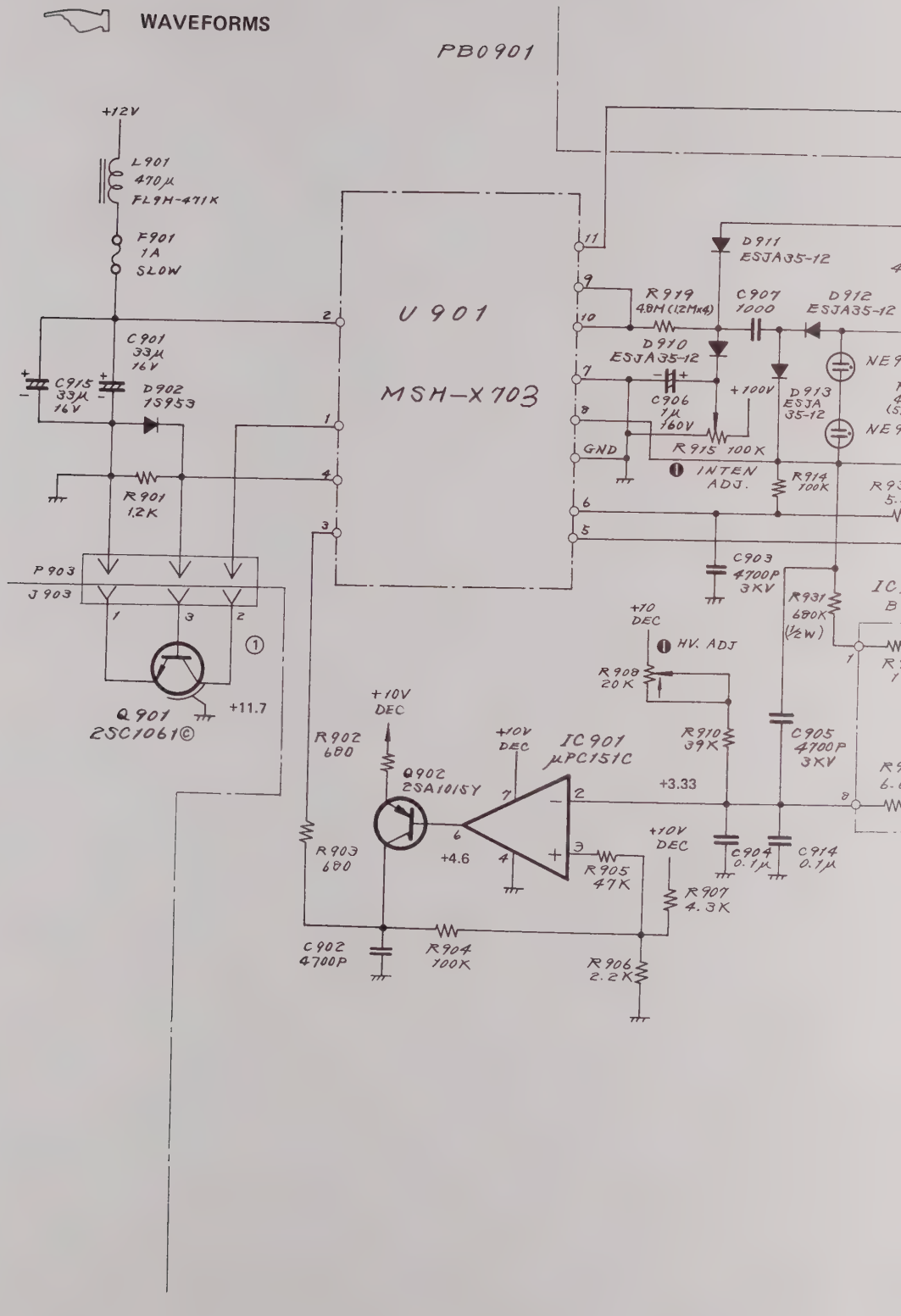
PB0401

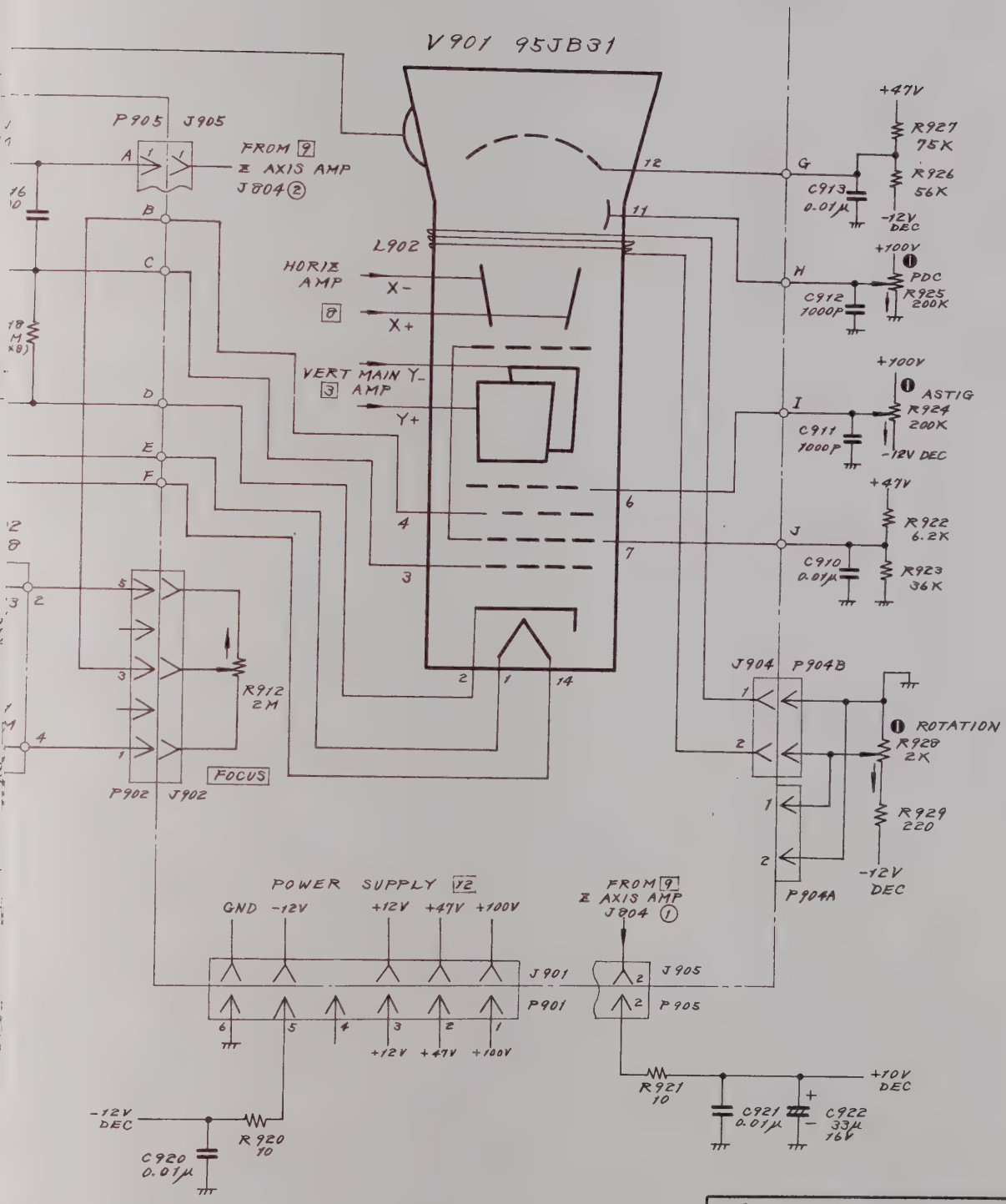
VOLTAGE & WAVEFORM READING CONDITIONS	
DELAY	Center
B TIME/DIV	0.2 mSEC
* DISP	A INT
** DISP	B
*** MODE	CHOP

名称 Title	
SS-3510/SS-3510TV Z AXIS AMPLIFIER	9
図番 Drwg No	
K-606703	3

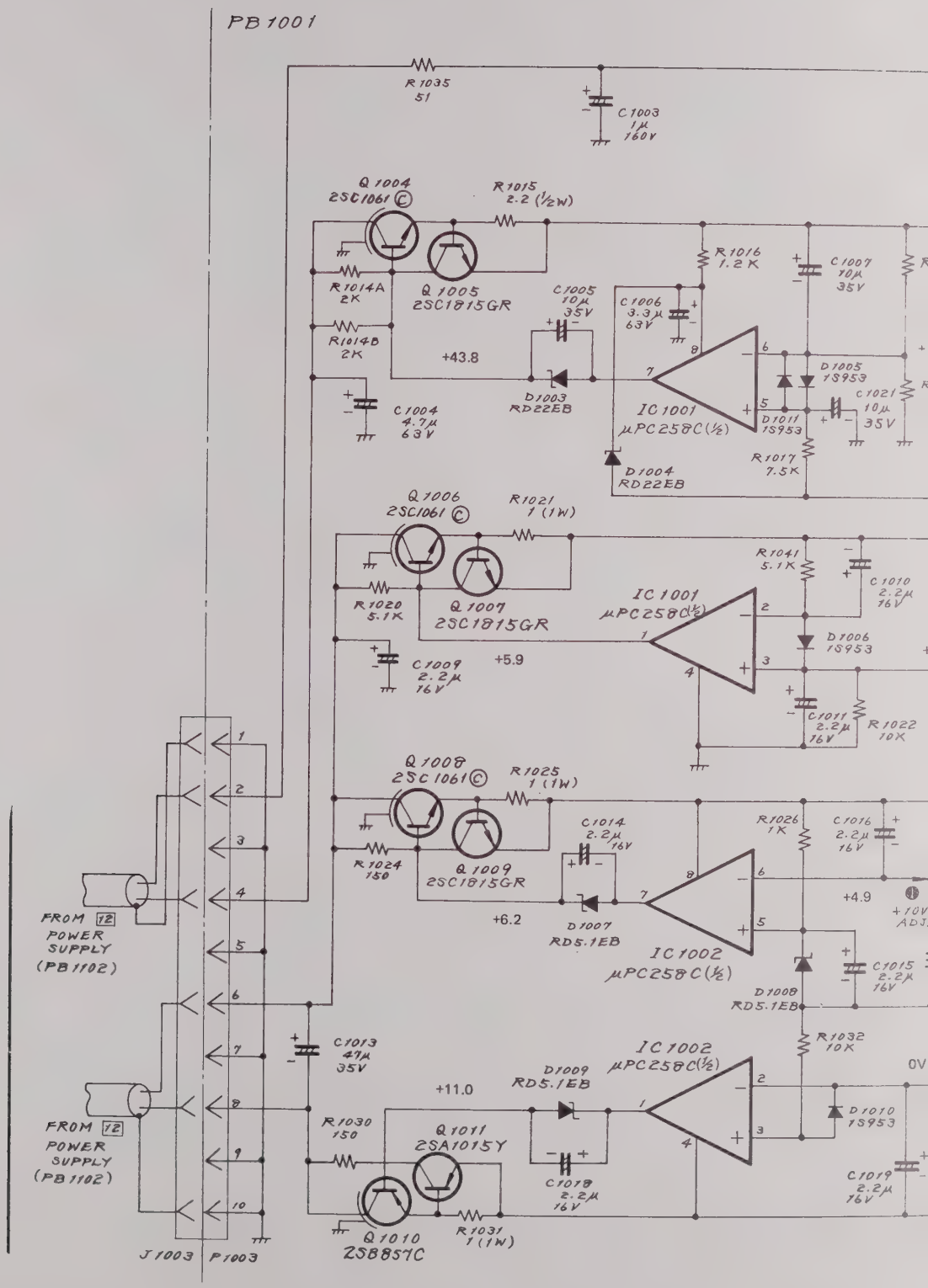

①
16V
≈+10V
20μS

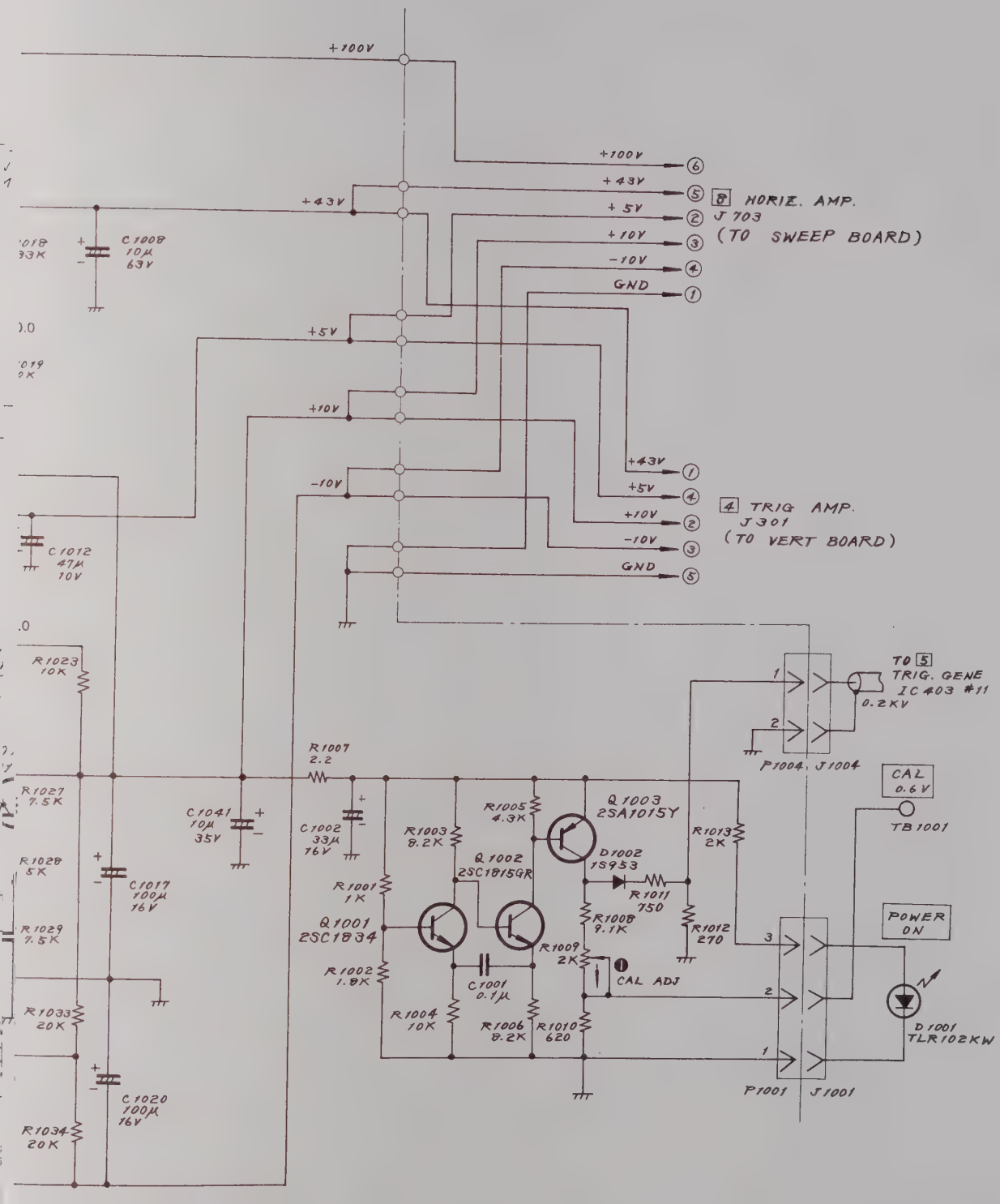
WAVEFORMS


PB0901
+12V
L901
470μ
FL9H-471K
F901
1A
SLOW
C901
33μ
16V
C915
33μ
16V
D902
1S953
R901
1.2K
U901
MSH-X703
P903
J903
Q901
2SC1061©
+11.7
D911
ESJA35-12
R919
4.8M (1.2M×4)
C907
1000
D912
ESJA35-12
D910
ESJA35-12
C906
1μ
160V
+100V
D913
ESJA
35-12
R915 100K
INTEN
ADJ.
GND
R914
100K
C903
4700P
3KV
R931
680K
(½W)
+10
DEC
HV. ADJ
R908
20K
+10V
DEC
R902
680
Q902
2SA1015Y
IC901
μPC151C
+3.33
+4.6
R910
39K
C905
4700P
3KV
C904
0.1μ
C914
0.1μ
R903
680
R905
47K
R907
4.3K
C902
4700P
R904
100K
R906
2.2K

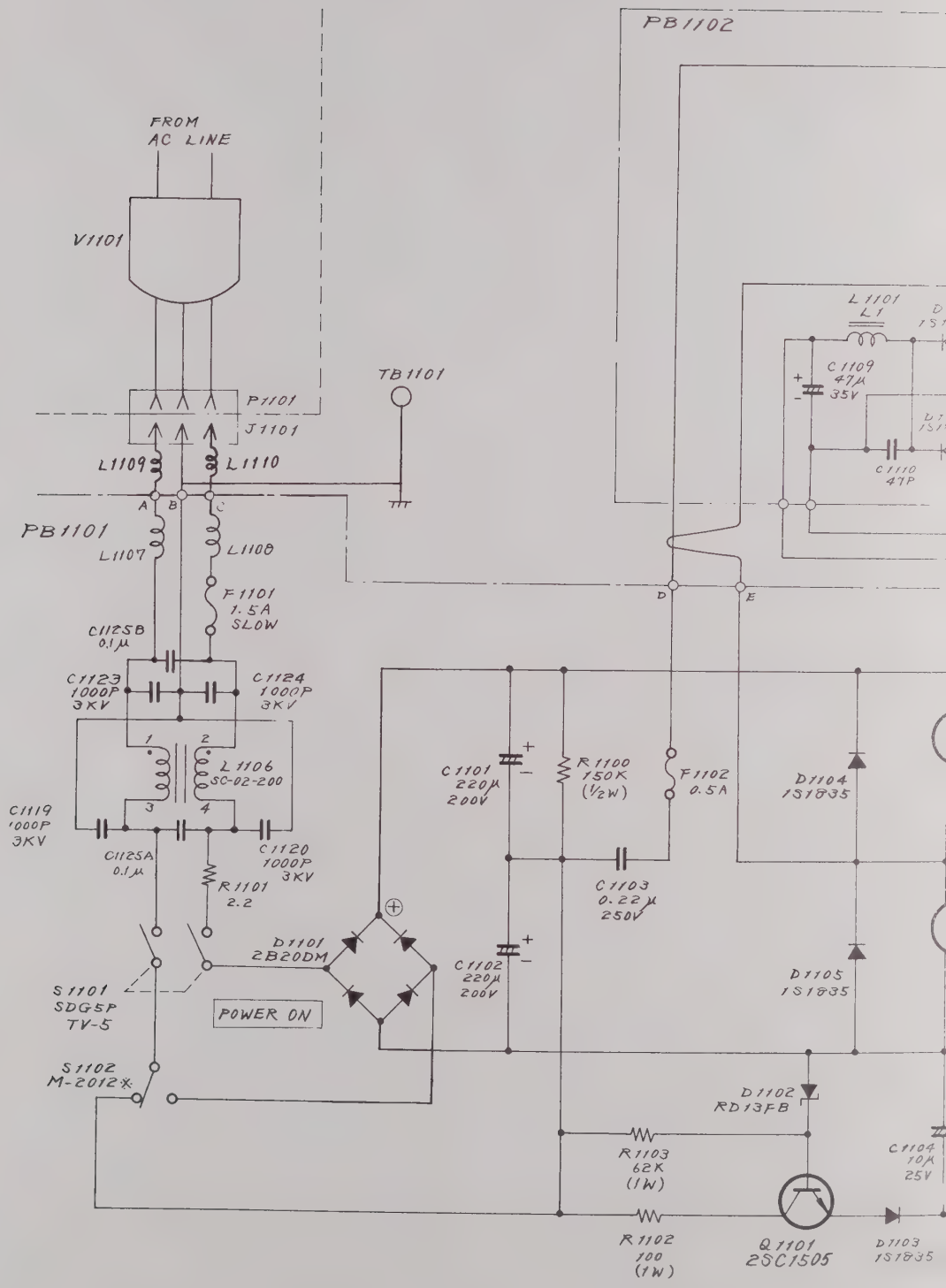


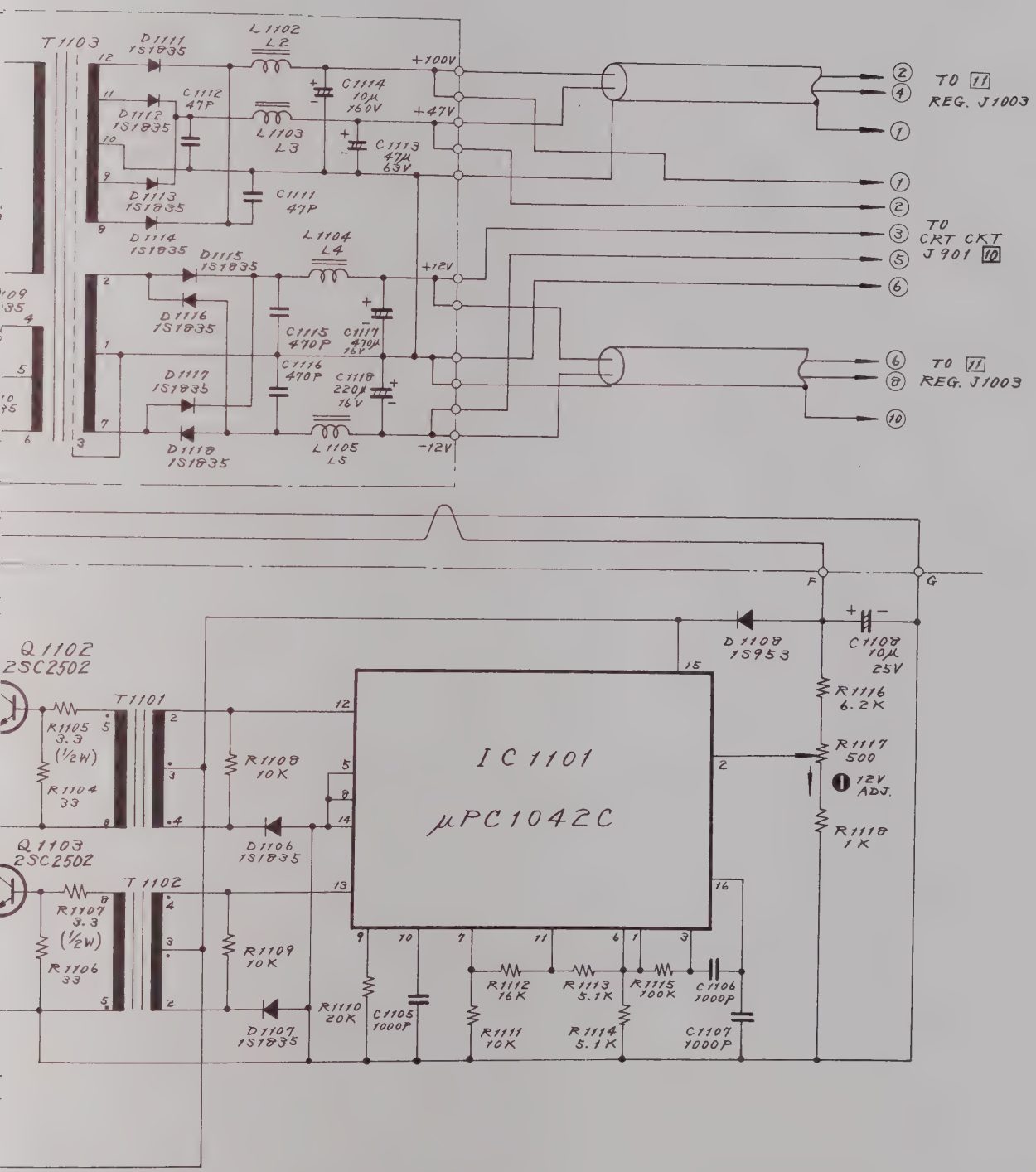
Title 名称	SS-3510/SS-3510TV CRT CIRCUIT 10
Drwg No 図番	K-606704 3


PB1001
R1035 51
C1003 1μ 160V
Q1004 2SC1061 (C)
R1015 2.2 (½W)
R1014A 2K
R1014B 2K
Q1005 2SC1815GR
C1005 10μ 35V
C1006 3.3μ 63V
R1016 1.2K
C1007 10μ 35V
+43.8
C1004 4.7μ 63V
D1003 RD22EB
IC1001 μPC258C(½)
D1005 1S953
D1011 1S953
C1021 10μ 35V
R1017 7.5K
D1004 RD22EB
Q1006 2SC1061 (C)
R1021 1 (1W)
R1020 5.1K
Q1007 2SC1815GR
R1041 5.1K
C1010 2.2μ 16V
C1009 2.2μ 16V
+5.9
D1006 1S953
C1011 2.2μ 16V
R1022 10K
Q1008 2SC1061 (C)
R1025 1 (1W)
R1024 150
Q1009 2SC1815GR
C1014 2.2μ 16V
R1026 1K
C1016 2.2μ 16V
+6.2
D1007 RD5.1EB
IC1002 μPC258C(½)
+4.9
+10V ADJ.
D1008 RD5.1EB
C1015 2.2μ 16V
FROM 12 POWER SUPPLY (PB1102)
C1013 47μ 35V
R1032 10K
0V
+11.0
D1009 RD5.1EB
IC1002 μPC258C(½)
D1010 1S953
R1030 150
Q1011 2SA1015Y
C1018 2.2μ 16V
C1019 2.2μ 16V
FROM 12 POWER SUPPLY (PB1102)
Q1010 2SB857C
R1031 1 (1W)
J1003 P1003



名称 Title SS-3510/SS-3510TV	11
REGULATOR & CALIBRATOR	
Drwg No. K-606705	3


PB1102
FROM
AC LINE
V1101
TB1101
P1101
J1101
L1109
L1110
A
B
C
PB1101
L1107
L1108
F1101
1.5A
SLOW
C1125B
0.1μ
C1123
1000P
3KV
C1124
1000P
3KV
1
2
L1106
SC-02-200
3
4
C1119
1000P
3KV
C1125A
0.1μ
C1120
1000P
3KV
R1101
2.2
S1101
SDG5P
TV-5
POWER ON
S1102
M-2012K
D1101
2B20DM
C1101
220μ
200V
R1100
150K
(½W)
F1102
0.5A
C1103
0.22μ
250V
C1102
220μ
200V
D1104
1S1835
D1105
1S1835
D1102
RD13FB
R1103
62K
(1W)
R1102
100
(1W)
Q1101
2SC1505
D1103
1S1835
L1101
L1
C1109
47μ
35V
C1110
47P
D
E
C1104
10μ
25V



名称 Title	SS-3510/SS-3510TV 12 POWER SUPPLY
図番 Drwg No	K-606706 3

SECTION 8
ELECTRICAL PARTS LIST

Ordering Information

Replacement parts may be ordered through an IWATSU Representative or directly from the factory. To be certain of receiving the proper parts, a ways include the following information with the order:

a. Model Number and serial number of the instrument on which the parts will be installed.
b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.
c. Iwatsu part number

For factory repair, contact the IWATSU agent and include the following information.

a. Model number and serial number of the instrument on which the work is to be performed.
b. Details concerning the nature of the malfunction, or, type of repair desired.
   Shipping instructions will be sent to you promptly.

How to use This Parts List

The parts list is divided into subsections corresponding to the schematic diagrams such as VERTICAL AMP, TRIG CIRCUIT, SWEEP GENERATOR, HORIZONTAL AMP. CRT CIRCUIT and POWER SUPPLY. Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

Abbreviations

Cap	.....	Capacitor
	Cer.	Ceramic
	Poly.	Polyethytel film
	Elect.	Aluminium electrolytic chemical
	Elect. tan ...	Tan-talum electrolytic chemical condenser
	[The symbol of F (farad) is omitted]	
Res.	.....	Resistor
	W.W.	Wire wound
	Comp.	Composition
	[The symbol of Ω (ohm) is omitted]	
FET	.....	Field Effect Transistor
Diode	.....	
	T. diode	Tunnel diode
	Z. diode	Zenner diode
	S.B. diode ..	Schottky barrier diode
	V.C. diode ..	Variable capacitance diode
	L.E.diode ...	Light emission diode
Var.	.....	Variable

CKT.NO.	DESCRIPTION	IWATSU PART NO.
VERTICAL ATTENUATOR		
C001A/B	Cap.,0.047μ,±20%, 250V,Poly.	DCF168041
C002A/B	Cap.,2～6p,Var., 250V,Cer.	DCV019611
C003A/B	Cap.,0.001μ, ±10%, 500V,Cer.	DCC151801
C004A/B	Cap.,2.2μ, ±20%, 16V, Elect.tan.	DCS440901
C005A/B	Cap.,0.01μ, +80～−20%,50V,Cer.	DCC133571
C006A/B	Cap., 100p, ± 10%, 50V,Cer.	DCC234001
C007A/B	Same as C005A/B	
C008A/B	Cap., 3.3～20p, Var., 250V,Cer.	DCV019591
C009A/B	Cap., 2.8～10p, Var., 250V,Cer.	DCV019601
C010A/B	Cap., 75p, ±5%,50V, Cer.	DCC237401
C011A/B	Same as C008A/B	
C012A/B	Same as C009A/B	
C013A/B	Cap 470p, ±5%, 50V, Cer.	DCC237411
C014A/B	Same as C008A/B	
C015A/B	Same as C008A/B	
C016A/B	Same as C008A/B	
C017A/B	Same as C009A/B	
C019A/B	Cap., 5p, ±10%,50V,Cer.	DCC250901
C021	Same as C004A/B	
R001A/B	Res., 10, ±5%, 1/8W, Carbon	DRD125001
R002A/B	Same as R001A/B	
R003A/B	Res., 22, ±5%, 1/8W, Carbon	DRD125011
R005A/B	Same as R001A/B	
R006A/B	Res., 1M, ±5%, 1/4W, Metal	DRE139741
R007A/B	Res., 470k, ±5%, 1/4W, Carbon	DRD135471
R008A/B	Res., 100k, ±5%, 1/4W, Carbon	DRD237591
R009A/B	Res., 100, ±1%, 1/4W, Metal	DRE535251
R010A/B	Same as R009A/B	
R011A/B	Res., 900k, ±0.5%, 1/4W, Metal	DRE139721
R012A/B	Res., 111k, ±0.5%, 1/4W, Metal	DRE233941
R014A/B	Res., 990k, ±0.5%, 1/4W, Metal	DRE139731
R015A/B	Res., 10.1k, ±0.5%, 1/4W, Metal	DRE233241
R017A/B	Res., 500k, ±0.5%, 1/4W, Metal	DRE139701
R018A/B	Same as R006A/B	
R019A/B	Res., 800k, ±0.5%, 1/4W, Metal	DRE139711
R020A/B	Res., 250k, ±0.5%, 1/4W, Metal	DRE139691
001A/B	Diode, 1S1544A	DDD010801
002A/B	Diode, 1S953	DDD010051
Q001A/B	FET, 2N5912	DTR250011
S001A/B	Slide Switch,SLBP223C-F	DSW055061
S002A/B	Rotary Switch, Ms14B6-10-9	DSW035231
J001A/B	BNC Connector, BNC247-R1	DCN040811
P002	Multi Connector,M33-07-30-134P	DCN034791
J002	Multi Connector, M31-M87-07	DCN034501

CKT.NO.	DESCRIPTION	IWATSU PART NO.
VERTICAL PREAMPLIFIER		
C101A/B	Cap., 0.01μ, +80～−20%, 50V, Cer.	DCC133571
C102A/B	Cap., 3.5～10p, Var., 250V, Cer.	DCV019601
C103A/B	Same as C102A/B	
C104A/B	Cap., 270p, ±10%, 50V, Cer.	DCC234701
C105A/B	Cap., 1000p, ±10%, 50V, poly.	DCF120111
C106A/B	Same as C105A/B	
C107A/B	Same as C101A/B	
C108A/B	Same as C105A/B	
C109A/B	Same as C105A/B	
C110A/B	Same as C102A/B	
C111A/B	Same as C101A/B	
C112A/B	Cap., 12p, ±10%, 50V, Cer.	DCC231901
C113A/B	Same as C102A/B	
C114A/B	Same as C105A/B	
C115A/B	Same as C105A/B	
C116A/B	Same as C101A/B	
C117A/B	Same as C105A/B	
C118A/B	Cap., 33μ, +100～−10%, 16V, Elect.	DCE220601
C119A/B	Same as C118A/B	
C120A/B	Cap., 1000p, ±10%, 50V, cer.	DCC131911
C121A/B	Same as C101A/B	
C125A/B	Same as C101A/B	
C126	Same as C120A/B	
R101A/B	Res., 100, ±5%, ¼W, Carbon	DRD237591
R102A/B	Res., 20k, Var., 0.3W, Metal	DRV411901
R103A/B	Res., 22k, ±1%, ¼W, Metal	DRE535811
R104A/B	Res., 220, ±1%, ¼W, Metal	DRE535331
R105A/B	Res., 4.7k, ±1%, ¼W, Metal	DRE535651
R106A/B	Same as R105A/B	
R107A/B	Res., 2.4k, ±1%, ¼W, Metal	DRE535581
R108A/B	Same as R107A/B	
R109A/B	Res., 15.0, ±1%, ¼W, Metal	DRE535291
R110A/B	Res., 100, Var., 0.3W, Metal	DRV411881
R111A/B	Same as R110A/B	
R112A/B	Res., 300, ±5%, ¼W, Carbon	DRD237701
R113A/B	Same as R112A/B	
R114A/B	Res., 1.2k, ±1%, ¼W, Metal	DRE535511
R115A/B	Same as R114A/B	
R116A/B	Res., 22, ±1%, ¼W, Metal	DRE510011
R117A/B	Same as R116A/B	
R118A/B	Res., 1k, Var., 0.25W, Carbon	DRV146531
R119A/B	Res., 51, ±1%, ¼W, Metal	DRE535181
R120A/B	Same as R116A/B	
R121A/B	Same as R110A/B	
R122A/B	Res., 9.1k, ±1%, ¼W, Metal	DRE535181
R123A/B	Res., 1k, ±1%, ¼W, Metal	DRE535491
R124A/B	Res., 1.3k, ±5%, ¼W, Carbon	DRD237861
R125A/B	Same as R124A/B	
R126A/B	Same as R109A/B	
R127A/B	Same as R109A/B	
R128A/B	Res., 510, ±1%, ¼W, Metal	DRE535421
R129A/B	Res., 430, ±1%, ¼W, Metal	DRE535401
R130A	Same as R129A/B	
R130B	Res., 330, ±1%, ¼W, Metal	DRE535371
R131A/B	Same as R130B	
R132A/B	Res., 500, Var., 0.3W, Metal	DRV411921
R133A/B	Res., 56k, ±5%, ¼W, Carbon	DRD238251
R134A/B	Res., 5k, Var., 0.3W, Metal	DRV411891
R135A/B	Res., 2k, Var., 0.3W, Metal	DRV411881
R136A/B	Res., 220, ±5%, ¼W, Carbon	DRD237671
R137A/B	Same as R136A/B	
R138A/B	Res., 2k, ±1%, ¼W, Metal	DRE535561
R139A	Same as R138A/B	
R139B	Res., 1.5k, ±1%, ¼W, Metal	DRE535531
R140A/B	Res., 2k, Var., 0.25W, Carbon	DRV146541
R141A/B	Same as R123A/B	
R142	Res., 200, Var., 0.3W, Metal	DRV411731
R143A/B	Res., 10, ±5%, ¼W, Carbon	DRD134351
R144A/B	Same as R143A/B	
R151A/B	Res., 2k, ±5%, ¼W, Carbon	DRD134901
R153A/B	Res., 6.2k, ±5%, ¼W, Carbon	DRD135021

CKT.NO.	DESCRIPTION	IWATSU PART NO.
R154	Res., 100, ±5%, ¼W, Carban	DRD134591
R155	Res., 1k, Var., 0.3W, Metal	DRV411911
R156A/B	Thermistor, 100	DDD080331
R157	Res., 8.2k, ±5%, ¼W, Cavbon	DRD238051
D101A/B	L.E. diode, TLY102KW	DDD070951
D102	L.E. diode, TLR102KW	DDD070941
D103	Same as D102	
Q101A/B	Transistor, 2SC1834	DTR131031
Q102A/B	Same as Q101A/B	
Q103A/B	Same as Q101A/B	
Q104A/B	Same as Q101A/B	
Q105A/B	Transistor, 2N3905	DTR150011
Q106A/B	Same as Q105A/B	
Q107A/B	Same as Q101A/B	
Q108A/B	Same as Q101A/B	
S101A/B	Slide switch, SSB04236	DSW055731
S102	Same as Q101A/B	
S118A/B	Ganged with R118A/B	
P101	Multi Connector, M36-02-30-114p	DCN034851
P102A/B	Same as P101	
J101	Multi Connector, M36 M87-02	DCN034601
J102A/B	Same as J101	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
VERTICAL MAIN AMPLIFIER		
C203	Cap., 0.01μ, +80～-20%, 50V, Cer.	DCC133571
C204	Cap., 220p, ±10%, 50V, Cer.	DCC234501
C205	Cap., 100p, ±10%, 50V, Cer.	DCC234001
C206	Cap., 4.5～20p, Var., 250V, Cer.	
C207	Same as C206	
C209	Cap., 330p, ±10%, 50V, Cer.	DCC234901
C210	Same as C203	
C211	Cap., 22p, ±10%, 50V, Cer.	
C212	Same as C203	
C213	Same as C203	
C214	Cap., 200p, ±10%, 50V, Cer.	DCC234441
C215	Cap., 470p, ±10%, 50V, Cer.	DCC230011
C216	Same as C215	
C217	Same as C209	
C218	Cap., 2.2μ, ±20%, 16V, Eleat. Tan.	DCF440901
C220	Cap., 6800p, ±10%, 50V, Poly.	DCF120211
C221	Same as C203	
C222	Cap., 3.5～10p, Var, 250V, Cer.	
C223	Cap., 220p, ±10%, 50V, Cer.	DCC234501
C224	Same as C223	
C225	Cap., 1000p, ±10 , 50V, Cer.	DCF120111
C226	Same as C218	
C227	Same as C223	
C228	Cap., 10μ, ±20%, 6.3V, Elect.	DCE910071
C229	Same as C203	
C230	Same as C203	
C231	Same as C203	
C232	Same as C203	
C233	Same as C203	
C234	Same as C203	
C235	Same as C203	
R201	Res., 1.5k, ±1%, ¼W, Metal	DRE535531
R202	Same as R201	
R203	Res., 270, ±1%, ¼W, Metal	DRE535351

CKT.NO.	DESCRIPTION	IWATSU PART NO.
R204	Same as R203	
R205	Res., 22k, ±5%, ¼W, Carbon	DRD238151
R206	Res., 510, ±1%, ¼W, Metal	DRE535421
R207	Same as R206	
R208	Res., 68, ±5%, ¼W, Carbon	DRD237551
R209	Same as R208	
R210	Res., 91, ±1%, ¼W, Metal	DRE535241
R211	Same as R210	
R212	Res., 10k, Var., 0.3W, Metal	DRV411931
R213	Res., 51, ±1%, ¼W, Metal	DRE535181
R214	Res., 500, Var., 0.3W, Metal	DRV411921
R215	Res., 2k, Var., 0.3W, Metal	DRV411881
R216	Res., 820, ±1%, ¼W, Metal	DRE535471
R217	Res., 1.1k, ±1%, ¼W, Metal	DRE535501
R219	Res., 47k, ±5%, ¼W, Carbon	DRD135231
R220	Res., 1.80, ±1%, ¼W, Metal	DRE535311
R221	Same as R220	
R222	Res., 47, ±1%, ¼W, Metal	DRE535171
R223	Res., 620, ±5%, 1W, Metal	DRS220901
R224	Same as R223	
R225	Res., 51, ±5%, ¼W, Carbon	DRD134521
R226	Same as R225	
R227	Res., 100, ±5%, ¼W, Carbon	DRD237591
R228	Res., 4.3k, ±5%, ¼W, Carbon	DRD134981
R229	Same as R228	
R230	Res., 1k, ±5%, ¼W, Carbon	DRD237831
R231	Res., 10k, ±5%, ¼W, Carbon	DRD238071
R232	Res., 1.2k, ±5%, ¼W, Carbon	DRD237851
R233	Same as R232	
R234	Res., 220, ±5%, ¼W, Carbon	DRD237671
R235	Res., 47k, ±5%, ¼W, Carbon	DRD238231
R236	Same as R235	
R237	Same as R235	
R238	Same as R235	
R239	Same as R235	
R240	Same as R235	
R241	Res., 2k, ±5%, ¼W, Carbon	DRD237901
R242	Res., 5.1k, ±5%, ¼W, Carbon	DRD238001
R243	Res., 240, ±1%, ¼W, Metal	DRE535341
R244	Same as R243	
R245	Same as R214	
R246	Same as R234	
R247	Same as R234	
R248	Res., 2.7k, ±5%, ¼W, Carbon	DRD237931
R249	Res., 4.7k, ±5%, ¼W, Carbon	DRD238001
R250	Same as R249	
R251	Res., 620, ±5%, 2W, Metal	DRS230861
R252	Same as R251	
R253	Thermistor, 5k	DDD080191
R254	Res., 5.6k, ±5%, ¼W, Carbon	DRD135011
R255	Res., 3k, ±5%, ¼W, Carbon	DRD237941
R256	Res., 4.3k, ±5%, ¼W, Carbon	DRD237981
R257	Res., 68, ±1%, ¼W, Metal	DRE535211
R258	Res., 6.8k, ±5%, ¼W, Carbon	DRD238031
R259	Res., 1.8k, ±5%, ¼W, Carbon	DRD237891
D201	Diode, 1S953	DDD010051
D202	Same as D201	
D203	Same as D201	
D204	Same as D201	
D205	Same as D201	
D206	Same as D201	
D207	Same as D201	
D208	Same as D201	
D209	Same as D201	
D210	Same as D201	
D211	Same as D201	
D212	Same as D201	
D213	Same as D201	
D214	Diode, 1N34A	DDD010091
D215	Same as D214	
D216	Same as D214	
D217	Same as D214	
D218	Same as D214	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
D219	Same as D214	
D220	Same as D201	
D221	V.C. Diode, 1S1658	DDD011011
D222	Same as D214	
Q201	Transistor, 2SC2037	DTR137591
Q202	Same as Q201	
Q203	Same as Q201	
Q204	Same as Q201	
Q205	Same as Q201	
Q206	Same as Q201	
Q207	Transistor, 2SC1199	DTR137741
	Heat sink, KQA-6/825	MHN000751
Q208	Same as Q207	
	Heat sink, KQA-6/825	MHN000751
Q209	Transistor, 2SA1015Y	DTR116111
Q210	Transistor, 2SC1815GR	DTR137781
Q211	Same as Q210	
Q212	Transistor, 2SC1834	DTR131031
Q213	Same as Q210	
Q214	Same as Q210	
IC201	Integrated circuit, SN7470N	DIC110711
IC202	Integrated circuit, SN7400N	DIC110011
L202	Inductor, Peaking Coil	DCL151301
L203	Same as L202	
L204	Ferrite Bead Core, L82 OP-03-03-1H	DCL320251
L205	Same as L204	
P201	Multi Connector, M33-07-30-114p	DCN034691
J201	Multi Connector, M31-M87-07	DCN034951
S201	Rotary Switch, MRY-106 special	DSW035281
DL201	Delay Line, CD-3 1.2M	KHB029011

CKT.NO.	DESCRIPTION	IWATSU PART NO.
	TRIGGER AMPLIFIER	
C301	Cap., 0.01μ, +80～−20%, 50V, Cer.	DCC133571
C302	Same as C301	
C303	Same as C301	
C304	Same as C301	
C305	Cap., 2.2μ, ±20%, 16V, Elect.Tan.	DCS440901
C306	Same as C305	
C307	Cap., 4.7μ, +100～−10%, V, Elect.	DCE242581
C308	Same as C305	
C309	Same as C305	
C310	Cap., 47μ, +100～−10%, V, Elect.	DCE212651
C311	Same as C301	
C312	Same as C301	
C313	Cap., 22p, ±10%, 50V, Cer.	DCC232401
C314	Same as C313	
R301	Res., 47, ±5%, ¼W, Carbon	DRD237511
R302	Same as R301	
R303	Res., 470, ±1%, Metal	DRE535411
R304	Res., 1k, ±1%, Metal	DRE535491
R305	Same as R304	
R306	Res., 3.9k, ±5%, ¼W, Carbon	DRD237971
R307	Res., 1k, ±5%, ¼W, Carbon	DRD237831
R308	Res., 1.3k, ±5%, ¼W, Carbon	DRD237861
R309	Res., 240, ±1%, ¼W, Metal	DRE535341
R310	Same as R309	
R311	Res., 8.2k, ±1%, ¼W, Metal	DRE535711
R312	Same as R301	
R313	Same as R301	
R314	Same as R304	
R315	Same as R303	
R316	Same as R304	
R317	Res., 100, ±5%, ¼W, Carbon	DRD134591
R318	Same as R308	
R319	Same as R308	
R320	Same as R317	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
R321	Same as R308	
R322	Same as R308	
R323	Res., 1.2k, ±5%, ¼W, Carbon	DRD237851
R324	Same as R323	
R325	Res., 10, ±5%, ¼W, Carbon	DRD237351
R326	Same as R301	
R327	Same as R301	
R328	Same as R301	
R329	Same as R301	
D301	Diode, 1S953	DDD010051
D302	Same as D301	
D304	Same as D301	
D305	Same as D301	
D306	Same as D301	
D307	Same as D301	
D308	Same as D301	
D309	Z.Diode, RD3.9EB	DDD032921
D310	Same as D309	
Q301	Transistor, 2N3905	DTR150011
Q302	Same as Q301	
Q303	Transistor, 2SC2037	DTR137591
Q304	Same as Q303	
Q305	Transistor, 2SC1834	DTR131031
Q306	Same as Q305	
Q307	Same as Q301	
Q308	Same as Q301	
Q309	Same as Q303	
Q310	Same as Q303	
IC301	Integrated circuit, UA733CN	DIC623081
P301	Mueti Connector, M36-05-30-114p	DCN034881
P302	Mueti Connector, M33-08-30-114p	DCN034701
J301	Mueti Connector, M36-M87-05	DCN034631
J302	Mueti Connector, M31-M87-08	DCN034511

CKT.NO.	DESCRIPTION	IWATSU PART NO.
TRIGGER GENERATOR		
R401	Res., 750k, ±1%, ¼W, Metal	DRE139751
R402	Res., 333k, ±1%, ¼W, Metal	DRE139761
R403	Res., 470k, ±5%, ¼W, Carbon	DRD238471
R404	Res., 390, ±5%, ¼W, Carbon	DRD237731
R405	Res., 100, ±5%, ¼W, Carb n	DRD237591
R406	Res., 1M, ±5%, ¼W, Metal	DRE139741
R407	Res., 2.2k, ±5%, ¼W, Carbon	DRD237911
R408	Res., 3.3k, ±5%, ¼W, Carbon	DRD237951
R409	Same as R404	
R410	Res., 1.5k, ±5%, ¼W, Carbon	DRD237871
R411	Res., 20k, Same as R408	DRV411901
R412	Same as R408	
R413	Res., 50k +200k, Var., 0.08W, Carbon	DRV131371
R414	Res., 120, ±5%, ¼W, Carbon	DRD237611
R415	Same as R414	
R416	Res., 510, ±5%, ¼W, Carbon	DRD237761
R417	Res., 150, ±5%, ¼W, Carbon	DRD237631
R418	Res., 680, ±5%, ¼W, Carbon	
R419	Same as R418	
R420	Same as R418	
R421	Res., 180, ±5%, ¼W, Carbon	DRD237651
R422	Same as R421	
R423	Res., 750, ±5%, ¼W, Carbon	DRD237801
R424	Same as R423	
R425	Res., 2k, Var., 0.3W, Metal	DRD411881
R426	Res., 1.2k, ±5%, ¼W, Carbon	DRD237851
R427	Res., 10k, ±5%, ¼W, Carbon	DRD238071
R428	Same as R426	
R429	Same as R404	
R430	Res., 470, ± 5%, ¼W, Carbon	DRD237751
R433	Res., 330, ± 5%, ¼W, Carbon	DRD134711
R434	Res., 47, ± 5%, ¼W, Carbon	DRD134511
R435	Res., 47, ± 5%, ¼W, Carbon	DRD237511
R436	Res., 4.7k, ±5%, ¼W, Carbon	DRD237991

CKT.NO.	DESCRIPTION	IWATSU PART NO.
C401	Cap., 0.047μ, ±20%, 250V, poly.	DCF168041
C402	Cap., 0.047μ, ±10%, 50V, poly.	DCF120311
C404	Cap., 1000p, ± 10%, 50V, cer.	DCC131801
C405	Cap., 0.01μ, + 80 ~ − 20%, 50V, Cer.	DCC133571
C406	Same as C405	
C408	Same as C405	
C409	Same as C405	
C410	Cap., 2.2μ, ±20%, 16V, Elect.tan.	DCS440901
C411	Same as C405	
C412	Same as C405	
C413	Same as C410	
C414	Cap., 22p, ±10%, 50V, Cer.	DCC232401
C415	Same as C410	
C416	Cap., 82P, ±10%, 50V, Cer.	DCC233801
C417	Cap., 4700p, ±10%, 50V, Cer.	DCC132901
C418	Same as C417	
C419	Same as C405	
C420	Cap., 33p, ±10%, 500V, Cer.	DCC252801
C422	Same as C405	
C423	Same as C405	
C424	Same as C405	
D401	Diode, 1S1544A	DDD010801
D402	Diode, 1S953	DDD010051
D403	Same as D402	
D404	Same as D402	
D405	Same as D402	
D406	L.E.Diode, TLG102kw	DDD070931
Q401	FET, 2SK19-Y	DTR215211
Q402	Transistor, 2SC1834	DTR131031
Q403	Same as Q402	
Q404	Transistor, 2SC2037	DTR137591
Q405	Same as Q404	
Q406	Transirtor, 2N5771	DTR150121

CKT.NO.	DESCRIPTION	IWATSU PART NO.
Q407	Same as Q406	
IC401	Integrated circuit, MC10107	DIC322041
IC402	Integrated circuit, SN74S00N	DIC170011
IC403	Integrated circuit, SN74LS290N	DIC142451
IC404	Integrated circuit, SN74LS96N	DIC140971
IC405	Same as IC402	
S401	Slide switch, SLBP222C	DSW051011
S402	Slide switch, SLBP223C-F	DSW055061
S403	Same as S401	
S405	Same as S402	
S406	Same as S401	
P401	Multi connector, M36-02-30-114p	KCN034851
J401	Multi connector, M36 M87-02	KCN034601
J402	BNC connector, BNC-BR-226	DCN040581

SWEEP GENERATOR

CKT.NO.	DESCRIPTION	IWATSU PART NO.
C501	Cap., 100p, ±10%, 50V, Cer.	DCC234001
C502	Cap., 5p, ±0.25%, 50V, Cer.	DCC230901
C503	Cap., 0.01μ, +80%~−20%, 50V, Cer.	DCC133571
C504	Same as C503	
C506	Cap., 0.1μ, ±10%, 50V, Poly.	DCF120351
C507	Same as C503	
C508	Cap., 270p, ±10%, 50V, Cer.	DCC234701
C509	Same as C501	
C510	Same as C503	
C511	Same as C502	
C512	Same as C503	
C513	Same as C501	
C514	Same as C503	
C515	Cap., 2.2μ, ±20%, 16V, Elect.tan	DCS440901
C516	Same as C503	
C517	Same as C515	
C518	Same as C502	
C520	Same as C503	
C521	Same as C515	
C522	Same as C502	
C523	Cap., 120p, ±10%, 50V, Cer.	DCC234101
C524	Cap., 39p, ±10%, 50V, Cer.	DCC233001
C525	Same as C524	
C526	Same as C503	
C527	Same as C515	
C528	Same as C515	
C529	Same as C503	
C530	Same as C503	
R501	Res., 100, ±5%, ¼W, Carbon	DRD237591
R502	Res., 16k, ±5%, ¼W, Carbon	DRD238121
R503	Same as R502	
R504	Res., 560, ±5%, ¼W, Carbon	DRD237771
R505	Res., 12k, ±5%, ¼W, Carbon	DRD238091
R506	Res., 100, ±5%, ¼W, Carbon	DRD134591
R507	Res., 43k, ±5%, ¼W, Carbon	DRD238221
R508	Res., 2.7k, ±5%, ¼W, Carbon	DRD237931
R509	Res., 1.8k, ±5%, ¼W, Carbon	DRD237891
R510	Res., 1k, Var., 0.3W, Cermet	DRV411911
R511	Res., 510, ±5%, ¼W, Carbon	DRD237761
R512	Res., 4.7k, ±5%, ¼W, Carbon	DRD237991
R513	Res., 470, ±5%, ¼W, Carbon	DRD134751
R514	Res., 2k, ±5%, ¼W, Carbon	DRD237901
R515	Same as R506	
R517	Res., 20k, ±1%, ¼W, Metal	DRE535801
R518	Same as R512	
R519	Res., 20k, ±5%, ¼W, Carbon	DRD135141
R520	Res., 1k, ±5%, ¼W, Carbon	DRD134831
R521	Res., 10k, Var., 0.3W, Cermet	DRV411931
R522a	Res., 10k, Var., ⅛W, Carbon, Furnished as a unit with R522b	DRV142251
R522b	Same as R521 Furnished as a unit with R522a	DRV142251
R523	Same as R521	
R524	Res., 1k, ±5%, ¼W, Carbon	DRD237831
R530	Res., 47k, ±5%, ¼W, Carbon	DRD238231
R531	Same as R530	
R532	Res., 4.7k, ±5%, ¼W, Carbon	DRD134991
R533	Same as R512	
R534	Same as R512	
R535	Same as R512	
R536	Same as R512	
R537	Res., 300, ±5%, ¼W, Carbon	DRD237701
R538	Same as R530	
R539	Same as R501	
R540	Same as R508	
R541	Res., 470, ±5%, ¼W, Carbon	DRD237751
R542	Same as R504	
R543	Same as R505	
R544	Same as R501	
R545	Res., 43k, ±5%, ¼W, Carbon	DRD135221
R546	Res., 2.2k, ±5%, ¼W, Carbon	DRD237911

CKT.NO.	DESCRIPTION	IWATSU PART NO.
R547	Same as R508	
R548	Same as R510	
R549	Same as R532	
R550	Same as R511	
R551	Res., 47, ±5%, ¼W, Carbon	DRD237511
R552	Same as R502	
R553	Res., 9.1k, ±5%, ¼W, Carbon	DRD238061
R554	Same as R501	
R555	Same as R551	
R556	Same as R546	
R557	Same as R508	
R558	Res., 2k, Var., 0.3W, Cermet	DRV411881
R559	Same as R501	
R560	Same as R524	
R561	Res., 100k, ±5%, ¼W, Carbon	DRD238311
R564	Res., 10, ±5%, ¼W, Carbon	DRD237351
R565	Res., 10, ±5%, ¼W, Carbon	DRD134351
R566	Res., 8.2k, ±5%, ¼W, Carbon	DRD238051
R567	Same as R501	
R568	Same as R512	
R569	Res., 10k, ±5%, ¼W, Carbon	DRD238071
R570	Res., 1.2k, ±5%, ¼W, Carbon	DRD237851
R571	Res., 360, ±5%, ¼W, Carbon	DRD237721
R572	Same as R512	
R573A	Res., 3.3k, ±5%, ¼W, Carbon	DRD237951
R573B	Res., 10k, ±5%, ¼W, Carbon	DRD135071
D501	Z.diode, RD5.6EB	DDD032941
D502	Diode, 1S953	DDD010051
D503	Same as D501	
D504	Z.diode, RD3.9EB	DDD032921
D506	Same as D502	
D507	Same as D502	
D508	Same as D501	
D509	L.E.diode, TLY102KW	DDD070951
D511	Diode, 1N34A	DDD010091
D512	Same as D511	
D513	Same as D502	
D514	Same as D502	
D515	Same as D502	
D516	Same as D502	
D517	Same as D502	
Q501	Transistor, 2SC7815GR	DTR137781
Q502	FET, 2SK30A-Y	DTR210141
Q503	Transistor, 2N3905	DTR150011
Q504	Transistor, 2SC1834	DTR131031
Q505	Same as Q504	
Q506	Transistor, 2SA1015Y	DTR116111
Q510	Same as Q501	
Q511	Same as Q501	
Q512	Same as Q501	
Q513	Same as Q504	
Q514	Same as Q504	
Q515	Same as Q503	
Q516	Same as Q502	
Q517	Same as Q501	
Q518	Same as Q506	
Q519	Same as Q501	
Q520	Same as Q504	
Q521	Same as Q502	
IC501	Integrated circuit, SN7413N	DIC110141
IC502	Integrated circuit, SN74S74N	DIC170211
IC503	Integrated circuit, SN7410N	DIC110111
IC504	Integrated circuit, SN74S00N	DIC170011
IC505	Integrated circuit, μPC71A	DIC630011
S502	Push Switch, MS402red	DSW017021
S503	Slide Switch, SLBP223C	DSW052001
J501	Connector, M36-M87-03	DCN034611
J502	Connector, M36-M87-02	DCN034601

CKT.NO.	DESCRIPTION	IWATSU PART NO.
P501	Connector, M36－03－30－114P	DCN034861
P501	Connector, M36－02－30－114P	DCN034851

CKT.NO.	DESCRIPTION	IWATSU PART NO.
	TIMING CIRCUIT	
C601	Cap., 2.2μ, ±20%, 16V, Elect.tan	DCS440901
C602	Cap., 0.22μ, ± 20%, 35V, Elect.tan	DCS470301
C603	Cap., 0.022μ, ±10%, 50V, Poly.	DCF120271
C604	Cap., 2200p, ±10%, 50V, Poly.	DCF120151
C605	Cap., 220p, ±10%, 50V, Cer.	DCC234501
C606	Cap., 1μ, ±0.5%, 250V, Poly.	DCF260151
C607	Cap., 0.1μ, ±0.25%, 50V, Poly.	DCF420271
C608	Cap., 0.01μ, ±0.25%, 50V, Poly.	DCF125771
C609	Cap., 950p, ±0.25%, 50V, Poly.	DCF125751
C610	Cap., 39p, ±10%, 50V, Cer.	DCC233001
C611	Cap., 75p, ±5%, 50V, Cer.	DCC233701
C612	Cap., 3.3 ～ 20p, Var., 250V, Cer.	DCV019591
C613	Same as C611	
C614	Same as C612	
C615	Cap., 0.01μ, +80% ～ － 20%, 50V, Cer.	DCC133571
C616	Same as C615	
C617	Same as C608	
C618	Same as C609	
C619	Same as C610	
C620	Same as C611	
C621	Same as C612	
C622	Cap., 3.3μ, +75% ～ － 10%, 50V, Elect	DCE240351
C622	Same as C612	
R601	Res., 220, ±5%, ¼W, Carbon	DRD237671
R602	Res., 1.25M, ±1%, 0.5W, Metal	DRE540601
R603	Res., 2.5M, ±1%, 0.5W, Metal	DRE510611
R604	Res., 750k, ±1%, ¼W, Metal	DRE139751
R605	Res., 250k, ±0.5%, ¼W, Metal	DRE139691
R606	Same as R605	
R607A	Res., 125k, ±1%, ¼W, Metal	DRE132711
R607B	Res., 2.4k, ±1%, ¼W, Metal	DRE535581
R608	Res., 55.56k, ±0.5%, ¼W, Metal	DRE234221
R609	Res., 25k, ± 1%, ¼W, Metal	DRE132701
R610	Res., 20k, Var., ⅛W, Carbon,	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
	Furnished as a unit with S602	DRV146551
R611	Res., 33k, ±1%, ¼W, Metal	DRE532361
R612	Same as R611	
R613	Res., 6.8k, ±1%, ¼W, Metal	DRE535691
R615	Res., 7.5k, ±1%, ¼W, Metal	DRE535701
R616	Res., 5.6k, ±1%, ¼W, Metal	DRE535671
R617	Res., 2k, Var., 0.3W, Cermet	DRV411881
R618	Res., 22k, ±1%, ¼W, Metal	DRE535811
R620	Same as R601	
R621	Same as R604	
R622	Same as R605	
R623	Same as R605	
R624	Same as R607A	
R625	Same as R608	
R626	Same as R609	
R627	Same as R611	
R628	Res., 2.2k, ±5%, ¼W, Carbon	DRD134911
R631	Res., 10, ±5%, ¼W, Carbon	DRD237351
R634	Res., 13k, ±2%, ¼W, Metal	DRE134001
R636	Res., 510, ±2%, ¼W, Metal	DRE133661
R660	Res., 10, ±5%, ¼W, Carbon	DRD134351
D601	Diode, 1S953	DDD010051
D602	Same as D601	
D603	L.E.diode, TLR102kw	DDD070941
Q601	Transistor, 2N3905	DTR150011
Q602	Same as Q601	
S601	Rotary Switch,	
	PS22BH(24)3-6-20/H(24)2-4-12	DSW35241
S602	Ganged with R610	
J601	Connector, M36-M87-03	DCN034611
P601	Connector, M36-03-30-114P	DCN034861

CKT.NO.	DESCRIPTION	IWATSU PART NO.
	HORIZONTAL AMPLIFIER	
C701	Cap., 0.01μ, +80%～-20%, 50V, Cer.	DCC133571
C702	Same as C701	
C703	Cap., 5p, ±0.25%, 50V, Cer.	DCC230901
C704	Cap., 2～6p, Var., 250V, Cer.	DCV019611
C705	Same as C701	
C706	Cap., 0.5p, ±0.25%, 50V, Cer.	DCC230101
C707	Same as C706	
C708	Same as C704	
C709	Same as C703	
C710	Same as C701	
C711	Same as C701	
C712	Same as C701	
C713	Same as C701	
C714	Same as C701	
C715	Same as C701	
C721	Cap., 2.2μ, ±20%, 16V, Eleat.tan	DCS440901
R701	Res., 50k, Var., ⅛W, Carbon,	
	Furnished as a unit with R702 & S701	DRV146491
R702	Res., 10k, Var., ⅛W, Carbon,	
	Furnished as a unit with R701 & S701	DRV146491
R703	Res., 220k, ±5%, ¼W, Carbon	DRV238391
R704	Res., 16k, ±5%, ¼W, Carbon	DRD238121
R705	Res., 2.4k, ±1%, ¼W, Metal	DRE535581
R706	Res., 3.3k, ±5%, ¼W, Carbon	DRD237951
R707	Res., 6.8k, ±5%, ¼W, Carbon	DRD238031
R708	Same as R705	
R709	Res., 5.1k, ±5%, ¼W, Carbon	DRD238001
R710	Same as R709	
R711	Same as R706	
R712	Res., 2k, ±5%, ¼W, Carbon	DRD237901
R713	Same as R709	
R714	Same as R712	
R715	Same as R709	
R716	Res., 10k, ±5%, ¼W, Carbon	DRD238071

CKT.NO.	DESCRIPTION	IWATSU PART NO.
R717	Same as R716	
R718	Res., 8.2 k, ±1%, ¼W, Metal	DRE535711
R719	Res., 2k, Var., 0.3W, Cermet	DRV411881
R720	Same as R718	
R721	Res., 100, Var., 0.3W, Cermet	DRV411721
R722	Res., 750, ±1%, ¼W, Metal	DRE535461
R723	Res., 500, Var., 0.3W, Cermet	DRV411921
R724	Res., 56, ±1%, ¼W, Metal	DRE535191
R725	Res., 1.8k, ±1%, ¼W, Metal	DRE535551
R726	Same as R725	
R727	Res., 10k, ±1%, ¼W, Metal	DRE535731
R728	Same as R727	
R729	Same as R727	
R730	Same as R727	
R731	Res., 30k, ±5%, ¼W, Carbon	DRD238181
R732	Same as R731	
R737	Res., 27k, ±5%, 1W, Metal	DRS220601
R738	Same as R737	
R739	Res., 1.5k, ±1%, ¼W, Metal	DRE535531
R740	Same as R739	
R741	Res., 13k, ±1%, ¼W, Metal	DRE535761
R742	Res., 6.8k, ±1%, ¼W, Metal	DRE535691
R743	Res., 5k, Var., 0.3W, Cermet	DRV411891
R744A	Res., 1k, Var., 0.3W, Cermet	DRY411911
R744B	Res., 6.2 k, ±5%, ¼W, Cermet	DRD135021
R745	Res., 2.4k, ±5%, ¼W, Cermet	DRD237921
R751	Res., 10, ±5%, ¼W, Carbon	DRD237351
R752	Res., 8.2 k, ±5%, ¼W, Carbon	DRD238501
R753	Same as R752	
R754	Res., 100, ±5%, ¼W, Carbon	DRD237591
D701	Diode, 1S953	DDD010051
D702	Same as D701	
D703	Same as D701	
D704	Same as D701	
D705	Same as D701	
D706	Same as D701	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
D707	Diode, 1N34A	DDD010091
D708	Same as D707	
D709	Same as D701	
D710	Same as D701	
D711	Same as D701	
D712	Same as D701	
D713	Same as D701	
D714	Same as D701	
D715	Z-diode, RD6.2 EB	DDD030611
D716	Same as D715	
D717	Same as D701	
Q701	Transistor, 2SC1815GR	DTR137781
Q702	Same as Q701	
Q703	Transistor, 2SA1015Y	DTR116111
Q704	Same as Q703	
Q705	Transistor, 2N3905	DTR150011
Q706	Same as Q705	
Q707	Transistor, 2SC154C	DTR137681
Q708	Same as Q707	
Q709	Same as Q707	
Q710	Same as Q707	
RL701	Relay, MZ-9S	DKD026881
S701	Push-Pull Switch,	
	Furnished as a unit with R701 & R702	DRV146491
S702	Slide Switch, SLBP223C	DSW052001
J701	Connector, M36-M87-02	DCN034601
J702	Connector, M36-M87-04	DCN034621
J703	Connector, M36-M87-06	DCN034641
P701	Connector, M36-02-30-114P	DCN034851
P702	Connector, M36-04-30-114P	DCN034871
P703	Connector, M36-06-30-114P	DCN034891

Z AXIS AMPLIFIER

CKT.NO.	DESCRIPTION	IWATSU PART NO.
C801	Cap., 0.01μ, +80%～−20%, 50V, Cer.	DCC133571
C802	Cap., 2p, ±0.25%, 500V, Cer.	DCC250501
C803	Same as C801	
C804	Same as C801	
C805	Cap., 0.01μ, +100%～− 0%, 500V, Cer.	DCC153511
C806	Same as C801	
C807	Same as C801	
C808	Same as C801	
C809	Cap., 1000p, ±10%, 50V, Cer.	DCC131801
C810	Cap., 2.2μ, ±20%, 16V, Elect. tan	DCS440901
C811	Same as C801	
R801	Res., 1.8k, ±1%, ¼W, Metal	DRE535551
R802	Same as R801	
R803	Res., 6.8k, ±1%, ¼W, Metal	DRE535691
R804	Res., 4.7k, ±1%, ¼W, Metal	DRE535651
R805	Res., 20k, ±5%, 0.5W, Carbon	DRD144141
R807	Res., 10k, Var., 0.08W, Carbon	DRV131331
R808	Res., 2.2k, ±1%, ¼W, Metal	DRE535571
R809	Res., 5.1k, ±1%, ¼W, Metal	DRE535661
R810	Res., 10k, Var, 0.3W, Cermet	DRV411931
R811	Same as R809	
R812	Res., 2.7k, ±5%, ¼W, Carbon	DRD237931
R813	Same as R812	
R814	Same as R812	
R815	Res., 3.9k, ±5%, ¼W, Carbon	DRD237971
R816A/B	Res., 15k, ±1%, ¼W, Metal	DRE535771
R817	Res., 1.1k, ±1%, ¼W, Metal	DRE535501
R818	Res., 180, ±5%, ¼W, Carbon	DRD237651
R820	Res., 100, ±5%, ¼W, Carbon	DRD237591
R821	Res., 1.5k, ±1%, ¼W, Metal	DRE535531
R822	Res., 33k, ±5%, 1W, Metal	DRS220611
R823	Same as R820	
R824	Res., 33, ±5%, ¼W, Carbon	DRD237471
R831	Res., 1M, ±5%, ¼W, Carbon	DRD238551
R832	Res., 51k, ±5%, ±5%, ¼W, Carbon	DRD238001
R833	Res., 510, ±5%, ±5%, ¼W, Carbon	DRD134761
R834	Same as R817	
D801	Diode, 1S953	DDD010051
D802	Same as D801	
D803	Same as D801	
D804	Same as D801	
D806	Same as D801	
D807	Same as D801	
D808	Same as D801	
D809	Same as D801	
D810	Same as D801	
D811	Same as D801	
D812	Same as D801	
D813	Same as D801	
D814	Same as D801	
D815	Z-diode, RD5.6EB	DDD032941
D816	Same as D801	
D818	Same as D801	
D821	Z-diode, RD13EB	DDD033521
Q801	Transistor, 2SC1815GR	DTR137781
Q802	Same as Q801	
Q804	Transistor, 2SC154C	DTR137681
Q805	Same as Q803	
J801	Connector, M36−M87−03	DCN034611
J802	Connector, M36−M87−02	DCN034601
J803	BNC Connector, BNC−BR−226	DCN040581
J804	Same as J802	
P801	Connector, M36−03−30−114P	DCN34861
P802	Connector, M36−02−30−114P	DCN34851
P804	Same as P802	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
CRT CIRCUIT		
C901	Cap., 33μ, +50%～−10%, 16V, Elect.	DCE220601
C902	Cap., 4700p, ±10%, 50V, Poly.	DCF120191
C903	Cap., 4700p, ±20%, 3kV, Cer.	DCC172911
C904	Cap., 0.1μ, ±10%, 50V, Poly.	DCF120351
C905	Same as C903	
C906	Cap., 1μ, +100%～−10%, 160V, Elect.	DCE260251
C907	Cap., 1000p, ±20%, 3kV, Cer.	DCC171831
C910	Cap., 0.01μ, +80%～−20%, 50V, Cer.	DCC133571
C911	Cap., 1000p, ±10%, 500V, Cer.	DCC151801
C912	Same as C911	
C913	Same as C910	
C914	Same as C904	
C915	Same as C901	
C916	Same as C903	
C920	Same as C910	
C921	Same as C910	
C922	Same as C901	
R901	Res., 1.2k, ±5%, ¼W, Carbon	DRD134851
R902	Res., 680, ±5%, ¼W, Carbon	DRD237790
R903	Same as R902	
R904	Res., 100k, ±5%, ¼W, Carbon	DRD238311
R905	Res., 47k, ±5%, ¼W, Carbon	DRD238231
R906	Res., 2.2k, ±1%, ¼W, Metal	DRE535571
R907	Res., 4.3k, ±1%, ¼W, Metal	DRE535641
R908	Res., 20k, Var., 0.3W, Cermet	DRV411901
R910	Res., 39k, ±2%, ¼W, Metal	DRE134111
R912	Res., 2M, Var, ⅛W, Carbon	DRV142061
R914	Res., 100k, ±5%, ¼W, Carbon	DRD135311
R915	Res., 100k, Var., 0.5W, Cermet	DRV410231
R918A～H	Res., 5.1M, ±5%, ¼W, Carbon	DRD135721
R919A～D	Res., 1.2M, ±5%, ¼W, Carbon	DRD238571
R920	Res., 10, ±5%, ¼W, Carbon	DRD134351
R921	Same as R920	
R922	Res., 6.2k, ±5%, ¼W, Carbon	DRD238021
R923	Res., 36k, ±5%, ¼W, Carbon	DRD238201
R924	Res., 200k, Var., 0.3W, Cermet	DRV411941
R925	Same as R924	
R926	Res., 56k, ±5%, ¼W, Carbon	DRD238251
R927	Res., 75k, ±5%, ¼W, Carbon	DRD238281
R928	Res., 2k, Var., 0.5W, Cermet	DRV420181
R929	Res., 220, ±5%, ¼W, Carbon	DRD237671
R930	Res., 5.6, ±5%, 0.5W, Metal	DRS210161
R931	Res., 680k, ±2%, 0.5W, Metal	DRE144411
D902	Diode, 1S953	DDD010051
D903	Z-diode, RD5.1EB	DDD030571
D910	Diode, ESJA35-12	DDD022111
D911	Same as D910	
D912	Same as D910	
D913	Same as D910	
Q901	Transistor, 2SC1061C	DTR130661
Q902	Transistor, 2SA1015Y	DTR116111
IC901	Integrated Circuit, μPC151C	DIC610021
IC902	Integrated Circuit, B48	DIC820481
F901	Fuse (Slow Blow), FSA-1	DFU020141
L901	Induction Coil, FL9H-471k	DCL110751
L902	Rotation Coil, FS-32169	DCL140281
NE901	Neon Lamp, NL-2S	DLP025151
NE902	Same as NE901	
U901	High Voltage Unit, MSH-X703	DES050502
V901	Cathode Ray Tube, 95JB31	DET010521
J901	Connector, M36-M87-06	DCN034641
J902	Connector, M36-M87-05	DCN034631

CKT.NO.	DESCRIPTION	IWATSU PART NO.
J903	Connector, M36-M87-03	DCN034611
J904	Connector, M36-M87-02	DCN034601
J905	Same as J904	
P901	Connector, M36-06-30-134P	DCN034941
P902	Connector, M36-05-30-134P	DCN034931
P903	Connector, M36-03-30-134P	DCN034911
P904A/B	Connector, M36-02-30-134P	DCN034901
P905	Same as P904A/B	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
REGULATOR & CALIBRATOR		
C1001	Cap., 0.1μ, ±5%, 50V, Poly.	DCF121121
C1002	Cap., 33μ, +50%～-10%, 16V, Elect.	DCE220601
C1003	Cap., 1μ, +100%～-10%, 160V, Elect.	DCE260251
C1004	Cap., 4.7μ, +75%～-10%, 63V, Elect.	DCE242581
C1005	Cap., 10μ, ±20%, 35V, Elect.tan	DCS471301
C1006	Cap., 3.3μ, +75%～-10%, 63V, Elect.	DCE242591
C1007	Same as C1005	
C1008	Cap., 10μ, +50%～-10%, 63V, Elect.	DCE242601
C1009	Cap., 2.2μ, ±20%, 16V, Elect.tan	DCS440901
C1010	Same as C1009	
C1011	Same as C1009	
C1012	Cap., 47μ, +50%～-10%, 10V, Elect.	DCE212651
C1013	Cap., 47μ, +50%～-10%, 35V, Elect.	DCE230651
C1014	Same as C1009	
C1015	Same as C1009	
C1016	Same as C1009	
C1017	Cap., 100μ, +50%～-10%, 16V, Elect.	DCE220751
C1018	Same as C1009	
C1019	Same as C1009	
C1020	Same as C1017	
C1021	Same as C1005	
C1041	Same as C1005	
R1001	Res., 1k, ±1%, ¼W, Metal	DRE535491
R1002	Res., 1.8k, ±1%, ¼W, Metal	DRE535551
R1003	Res., 8.2k, ±5%, ¼W, Carbon	DRD238051
R1004	Res., 10k, ±1%, ¼W, Metal	DRE535731
R1005	Res., 4.3k, ±5%, ¼W, Carbon	DRD237981
R1006	Res., 8.2k, ±1%, ¼W, Metal	DRE535711
R1007	Res., 2.2, ±5%, ¼W, Carbon	DRD134191
R1008	Res., 9.1k, ±1%, ¼W, Metal	DRE535721
R1009	Res., 2k, Var., 0.3W, Cermet	DRV411881
R1010	Res., 620, ±1%, ¼W, Metal	DRE535441
R1011	Res., 750, ±5%, ¼W, Carbon	DRD237801
R1012	Res., 270, ±5%, ¼W, Carbon	DRD237691

CKT.NO.	DESCRIPTION	IWATSU PART NO.
R1013	Res., 2k, ±5%, ¼W, Carbon	DRD237901
R1014A/B	Res., 2k, ±1%, 0.5W, Metal	DRE540721
R1015	Res., 2.2k, ±5%, 0.5W, Metal	DRS210111
R1016	Res., 1.2k, ±5%, ¼W, Carbon	DRD134851
R1017	Res., 7.5k, ±5%, ¼W, Carbon	DRD135041
R1018	Res., 33k, ±1%, ¼W, Metal	DRE532361
R1019	Same as R1004	
R1020	Res., 5.1k, ±5%, ¼W, Carbon	DRD238001
R1021	Res., 1, ±5%, 1W, Metal	DRS220791
R1022	Same as R1004	
R1023	Same as R1004	
R1024	Res., 150, ±1%, 0.5W, Metal	DRE540731
R1025	Same as R1021	
R1026	Res., 1k, ±5%, ¼W, Carbon	DRD237831
R1027	Res., 7.5k, ±1%, ¼W, Metal	DRE535701
R1028	Res., 5k, Var., 0.3W, Cermet	DRV411891
R1029	Same as R1027	
R1030	Same as R1024	
R1031	Same as R1021	
R1032	Res., 10k, ±5%, ¼W, Carbon	DRD238071
R1033	Res., 20k, ±1%, ¼W, Metal	DRE535801
R1034	Same as R1033	
R1035	Res., 51, ±1%, ¼W, Metal	DRE535181
R1041	Same as R1020	
D1001	L.E.diode, TLR102kw	DDD070941
D1002	Diode, 1S953	DDD010051
D1003	Z.diode, RD22EB	DDD033541
D1004	Same as D1003	
D1005	Same as D1002	
D1006	Same as D1002	
D1007	Z.diode, RD5.1EB	DDD030571
D1008	Same as D1007	
D1009	Same as D1007	
D1010	Same as D1002	
D1011	Same as D1002	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
Q1001	Transistor, 2SC1834	DTR131031
Q1002	Transistor, 2SC1815GR	DTR137781
Q1003	Transistor, 2SA1015Y	DTR116111
Q1004	Transistor, 2SD288k	DTR145431
Q1005	Same as Q1002	
Q1006	Same as Q1004	
Q1007	Same as Q1002	
Q1008	Same as Q1004	
Q1009	Same as Q1002	
Q1010	Transistor, 2SB566C	DTR125981
Q1011	Same as Q1003	
IC1001	Integrated circuit, μPC258C	DIC613571
IC1002	Same as IC1001	
J1001	Connector, M36-M87-03	DCN034611
J1003	Connector, M31-M87-10	DCN034531
J1004	Connector, M36-M87-02	DCN034601
P1001	Connector, M36-03-30-134P	DCN034911
P1003	Connector, M33-10-30-134P	DCN034821
P1004	Connector, M36-02-30-134P	DCN034901

POWER SUPPLY

CKT.NO.	DESCRIPTION	IWATSU PART NO.
C1101	Cap., 220μ, +100%～−10%, 200V, Elect.	DCE160811
C1102	Same as C1101	
C1103	Cap., 0.22μ, ±10%, 250V, Poly.	DCF161391
C1104	Cap., 10μ, +50%～−10%, 25V, Elect.	DCE222501
C1105	Cap., 1000p, ±10%, 50V, Poly.	DCF120111
C1106	Same as C1105	
C1107	Same as C1105	
C1108	Same as C1104	
C1109	Cap., 47μ, +50%～−10%, 35V, Elect.	DCE230651
C1110	Cap., 47p, ±10%, 250V, Poly.	DCF168051
C1111	Same as C1110	
C1112	Same as C1110	
C1113	Cap., 47μ, +50%～−10%, 63V, Elect.	DCE242571
C1114	Cap., 10μ, +100%～−10%, 160V, Elect.	DCE260501
C1115	Cap., 470p, ±5%, 50V, Poly.	DCF127321
C1116	Same as C1115	
C1117	Cap., 470μ, +50%～−10%, 16V, Elect.	DCE220901
C1118	Cap., 220μ, +50%～−10%, 16V, Elect.	DCE220801
C1119	Cap., 1000p, ±20%, 3kv, Cer.	DCC171831
C1120	Same as C1119	
C1121	Cap., 4700p, ±20%, 3kv, Cer.	DCC172911
C1122	Same as C1122	
C1123	Same as C1119	
C1124	Same as C1119	
C1125 A/B	Cap., 0.1μ, ±20%, 400V, Poly.	DCF168021
R1100	Res., 150k, ±5%, 0.5W, Carbon	DRD144351
R1101	Res., 2.2, ±5%, 1W, W.W.	DRK120161
R1102	Res., 100, ±5%, 1W, Metal	DRS220311
R1103	Res., 62k, ±5%, 1W, Metal	DRS220911
R1104	Res., 33, ±5%, ¼W, Carbon	DRD237471
R1105	Res., 3.3, ±5%, 0.5W, Metal	DRS210131
R1106	Same as R1104	
R1107	Same as R1105	
R1108	Res., 10k, ±5%, ¼W, Carbon	DRD135071
R1109	Same as R1108	
R1110	Res., 20k, ±1%, ¼W, Metal	DRE535801
R1111	Res., 10k, ±1%, ¼W, Metal	DRE535731
R1112	Res., 16k, ±1%, ¼W, Metal	DRE535781
R1113	Res., 5.1k, ±1%, ¼W, Metal	DRE535661
R1114	Same as R1113	
R1115	Res., 100k, ±5%, ¼W, Carbon	DRD238311
R1116	Res., 6.2k, ±1%, ¼W, Mermet	DRE535681
R1117	Res., 500, Var., 0.3W, Cermet	DRV411921
R1118	Res., 1k, ±1%, ¼W, Metal	DRE535491
D1101	Diode, 2B20DM	DDD020251
D1102	Z.diode, RD13FB	DDD033741
D1103	Diode, 1S1835	DDD990131
D1104	Same as D1103	
D1105	Same as D1103	
D1106	Same as D1103	
D1107	Same as D1103	
D1108	Diode, 1S953	DDD010051
D1109	Same as D1103	
D1110	Same as D1103	
D1111	Same as D1103	
D1112	Same as D1103	
D1113	Same as D1103	
D1114	Same as D1103	
D1115	Same as D1103	
D1116	Same as D1103	
D1117	Same as D1103	
D1118	Same as D1103	
Q1101	Transistor, 2SC1507	DTR136951
Q1102	Transistor, 2SC1865	DTR137751
Q1103	Same as Q1102	
IC1101	Integrated circuit, μPC1042C	DIC690051
F1101	Fuse(Slow Blow), FSA1.5A	

CKT.NO.	DESCRIPTION	IWATSU PART NO.
F1102	Fuse, FA0.5A	DFU010151
L1101	Induction coil, L1	DCL290132
L1102	Induction coil, L2	DCL290142
L1103	Induction coil, L3	DCL290152
L1104	Induction coil, L4	DCL290162
L1105	Induction coil, L5	DCL290172
L1106	Induction coil, SC-02-200	DCL110761
L1107	Induction coil, L1	DCL110711
L1108	Same as L1107	
S1101	Push Switch, SDG5P(TV-5)	DSW011291
S1102	Toggle Switch, M-2012-S-DSW066041	DSW066041
T1101	Pulse Transformer, FS-32170	DCL240291
T1102	Same as T1101	
T1103	Converter Transformer	DCL290181
TB1101	Ground Terminal	DTA020501
J1101	Connector, SI-6431	DSK990271

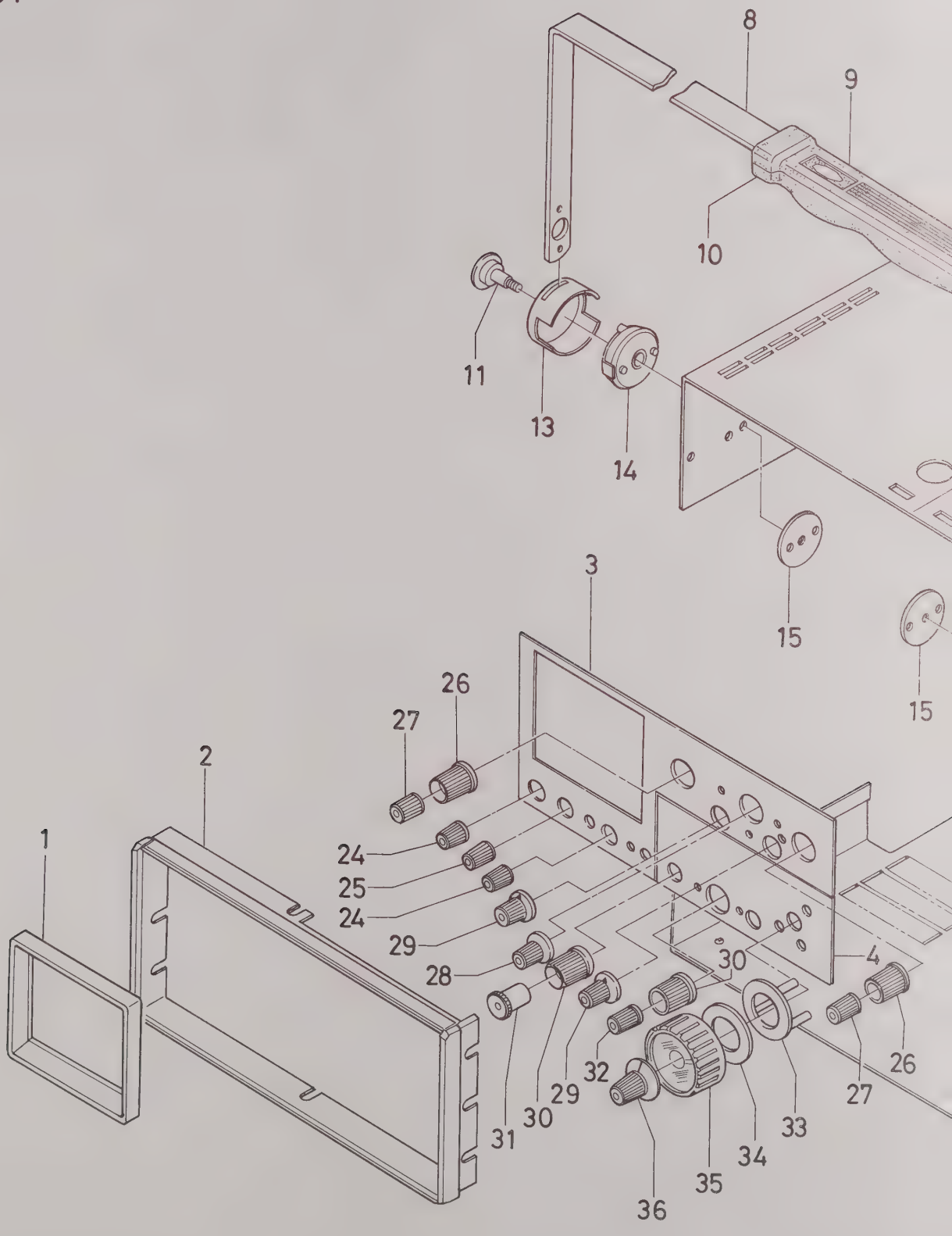
CKT.NO.	DESCRIPTION	IWATSU PART NO.
PRINTED CIRCUIT BOARD		
PB0001	ATTENUATOR BOARD	KPN127511
PB0101	VERTICAL BOARD	KPN127611
PB0401	HORIZONTAL BOARD	KPN127811
PB0402	HORIZONTAL SWITCH BOARD	KPN127711
PB0901	CRT CKT BOARD	KPN127911
PB0902	H.V. SEALED BOARD	KPN128711
PB1001	REGURATOR BOARD	KPN128011
PB1101	POWER SUPPLY BOARD	KPN128211
PB1102	CONVERTER BOARD	KPN128111

NOTES

SECTION 9
MECHANICAL PARTS LIST AND ILLUSTRATION

FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
9 - 1 - 1	BEZEL	1	KCM013231
- 2	PANEL FRAME, front	1	KCM051611
- 3	PANEL, front	1	KPA105721
- 4	H. PANEL, front	1	KPA105921
- 5	COVER, top	1	KBA389241
- 6	COVER, bottom	1	KBA440231
- 7	PANEL, rear	1	KPA106651
- 8	HANDLE	1	KBA389121
- 9	GRIP A, handle	1	KCM051721
-10	GRIP B, handle	1	KCM051821
-11	SCREW, handle	2	KMM029411
-12	COVER, handle lack, right	1	KCM013711
-13	COVER, handle lack, left	1	KCM013811
-14	STEPPER, handle	2	KDA004511
-15	SCREW SEAT PLATE, handle	2	KBA065311
-16	FOOT, rubber	4	AGM000111
-17	RIVET, RH-3x10A	4	MSQ930223
-18	SLIDE FOOT SEAT, plastic	2	KCM053611
-19	SLIDE FOOT, plastic	4	KCM053711
-20	SERIAL NO. PLATE	1	KRA051511
-22	SCREW, tapping, 3x10 mm	6	MTP130101
-23	PRESS NUT, 3 mm	40	MSQ910061
-24	INSULATION KNOB	2	KCM046511
-25	INSULATION KNOB	1	KCM052011
-26	KNOB, 161640 DSB	2	KCM048811
-27	KNOB, 101325 DR	2	KCM044211
-28	KNOB, 151332 SB	1	KCM046711
-29	KNOB, 151335 SB	3	KCM046811
-30	KNOB, 161660 DSB	2	KCM049011
-31	KNOB, 121330 DRP	1	KCM046911
-32	KNOB, 101332 DR	1	KCM053811
-33	SUPPORT, timing panel	1	KCM035111
-34	PANEL, timing switch	1	KPA106111
-35	KNOB, 371660 TB	1	KCM034611
-36	KNOB, 221520 SSB	1	KCM034711
-37	SCREW, flat head, 3x6 mm	1	
-38	SCREW, flat head, 3x8 mm	1	
-39	SCREW, truss head, 3x8 mm	1	
-40	SCREW, pan head, 3x10 mm	1	
-41	SCREW, pan head, 3x12 mm	1	
-42	SCREW, sems 1, 3 x 6 mm	1	
-43	WASHER, lock, 3 mm	2	
-44	WASHER, flat, 3 mm	2	
-45	BUSHING	1	
-46	NUT, 3 mm	1	

Fig. 9-1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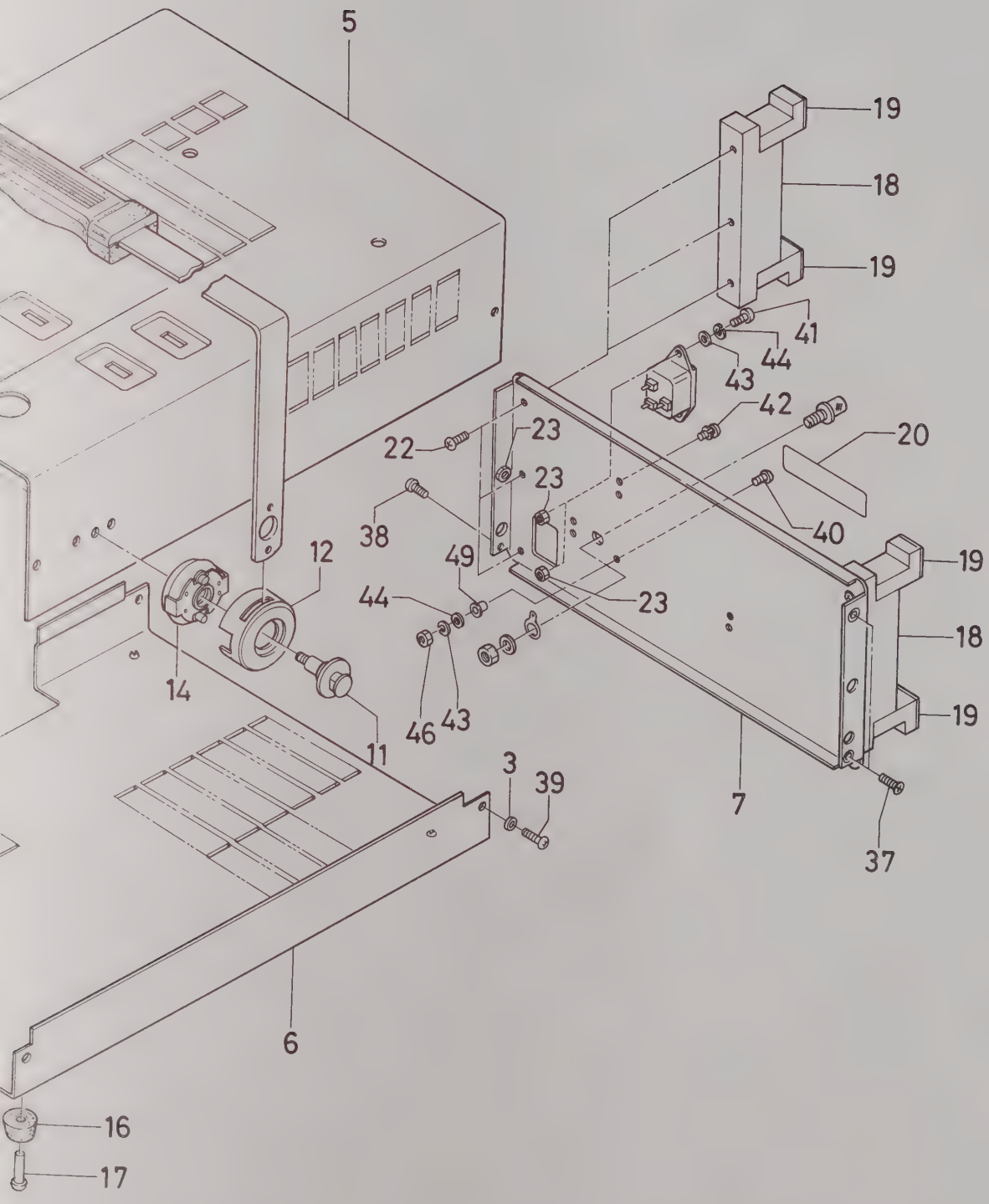
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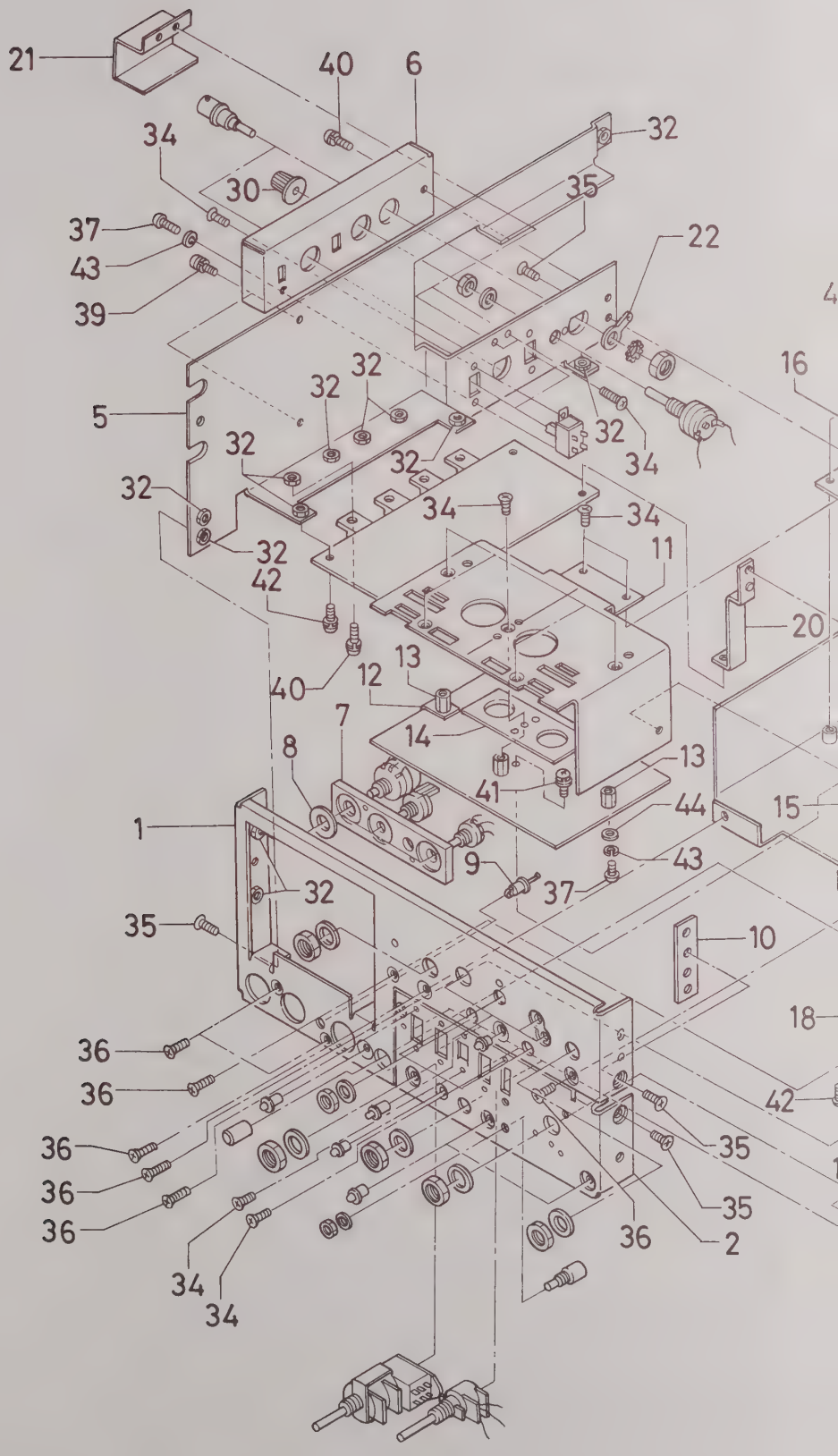
FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
9 - 2 - 1	SUB PANEL, front	1	KPA106451
- 2	H. SUB PANEL, front	1	KPA106531
- 3	CHASSIS	1	KBA390831
- 4	CHASSIS, center	1	KBA395641
- 5	FRAME	1	KFM029841
- 6	PANEL, left side	1	KPA106211
- 7	INSULATION PLATE	1	KPL087411
- 8	WASHER, nylon	3	KPL005711
- 9	TERMINAL, cal out	1	DTA010871
-10	PLATE, sub panel	1	KBA390921
-11	SHIELD PLATE, attenuator	1	KBA390131
-12	PLATE, grounding	1	KBA212711
-13	PROP	3	KMM157611
-14	PLATE, attenuator	1	KBA390311
-15	PROP	1	KMM157511
-16	MOUNTING PLATE, slide switch	3	KBA390621
-17	PLATE, heat sink	1	KBA390721
-18	SUPPORT, CRT buffer frame	1	KBA390021
-19	BRACKET, CRT circuit board	1	KBA391011
		1	KBA391011
-20	BRACKET, reglator board	1	KBA389711
-21	SHIELD PLATE, Z axis amplifier	1	KBA389921
-22	RAG, 10.2ϕ	1	KPS004311
-23	KNOB, power switch	1	KCM010321
-24	COUPLING, power switch	1	KCM006611
-25	EXTENSION ROD, power switch	1	KMM157411
-26	COUPLING, power switch	1	KCM006521
-27	PROP	1	KPL087511
-28	PLATE, danger display	1	KRA008011
-29	SUPPORT, CRT shield case	1	KBA389811
-30	KNOB, 151335 SB	3	KCM046811
-31	BRACKET, circuit board	10	KBA395711
-32	PRESS NUT, 3 mm	40	MSQ910061
-33	SETSCREW, 3x4 mm	1	
-34	SCREW, flat head, 2x4 mm	5(4)	
-35	SCREW, flat head, 3x6 mm	9	
-36	SCREW, flat head, 3x8 mm	6(4)	
-37	SCREW, pan head, 2x6 mm	2	
-38	SCREW, pan head, 3x18 mm	2	
-39	SCREW, semo 1, 3x6 mm	7	
-40	SCREW, semo 1, 3x8 mm	3	
-41	SCREW, semo 5, 3x6 mm	2	
-42	SCREW, semo 5, 3x8 mm	3	
-43	WASHER, lock, 2 mm	2	
-44	WASHER, flat, 2 mm	1	
-45	WASHER flat (large), 3 mm	1	
-46	WASHER, lock, 3 mm	2	
-47	WASHER, flat, 3 mm	2	
-48	NUT, 3 mm	2	

Fig. 9-2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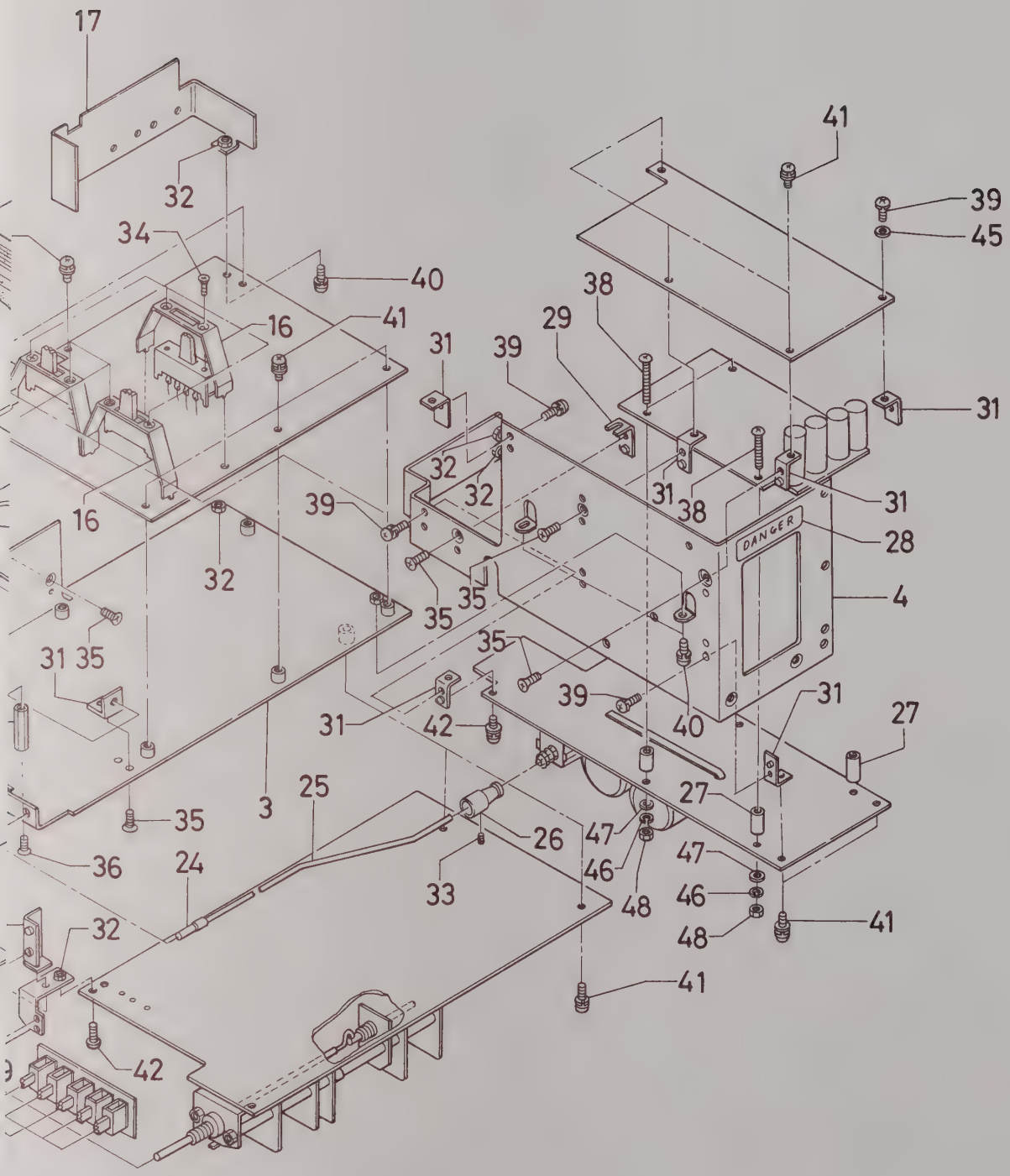
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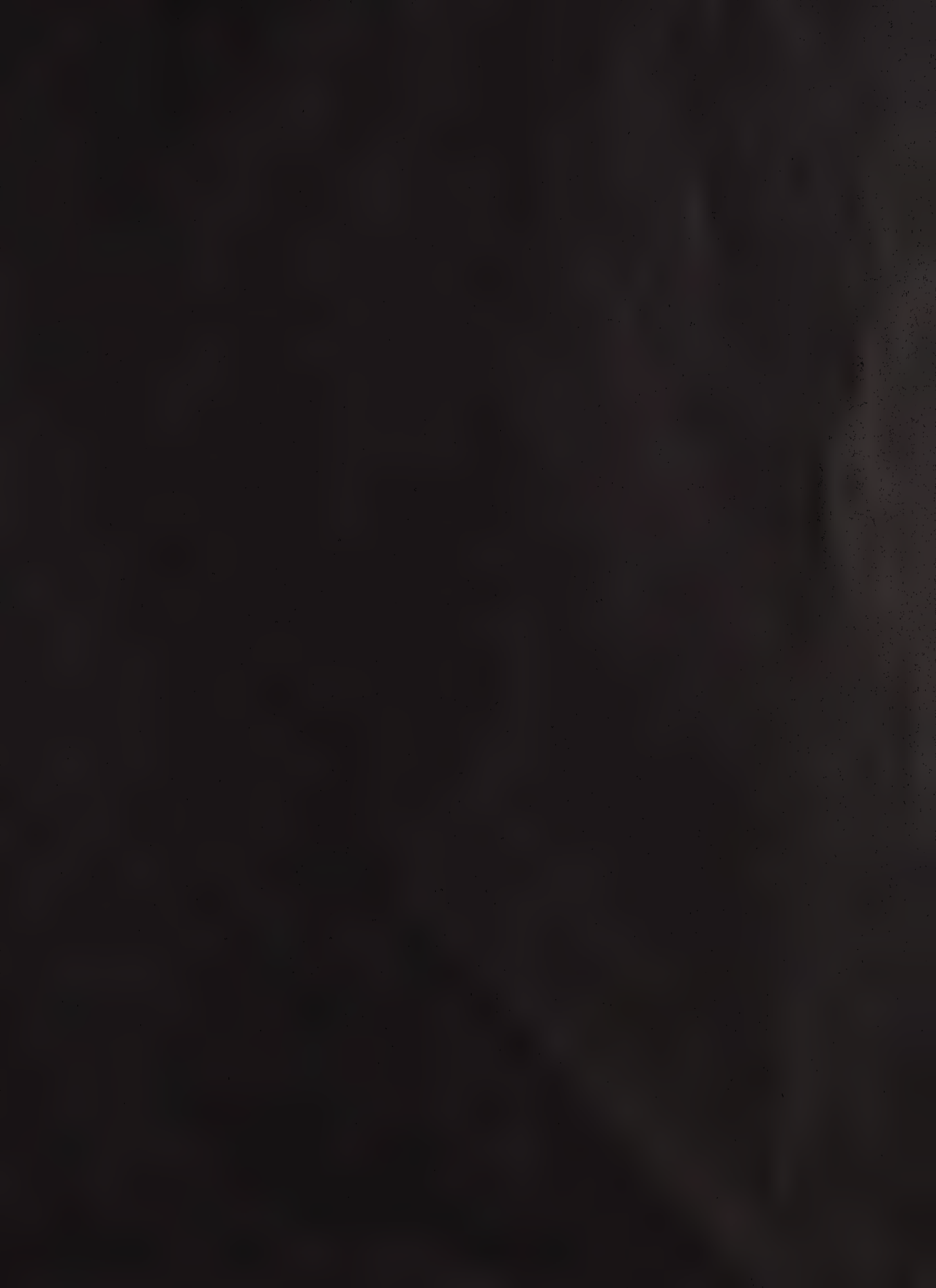
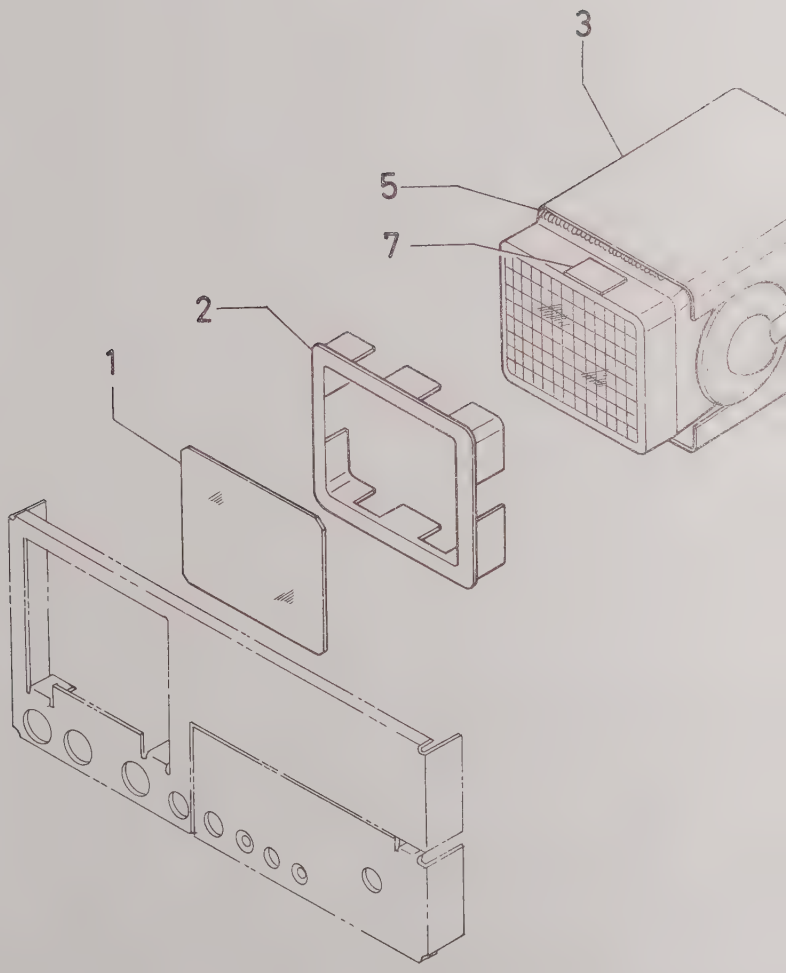
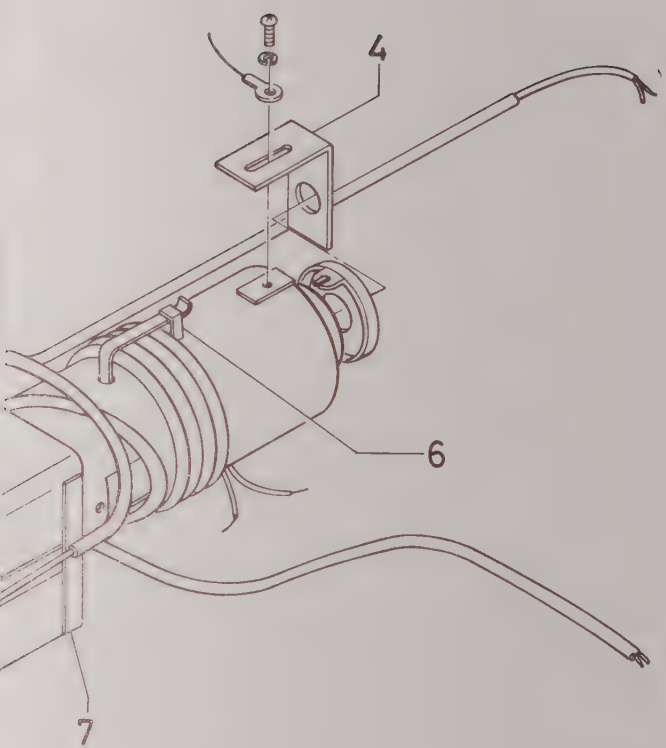


FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
9 - 3 - 1	FILTER, CRT	1	KPL014711
2	SUPPORT, CRT	1	KCM013411
3	SHIELD CASE, CRT	1	KBA389511
4	BRACKET, CRT	1	KBA389621
5	SPRING, CRT, grounding	1	KSP002621
6	BAND, vinyl	3	MHK000971
7	TAPE, urethane		52743501i

Fig. 9-3

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